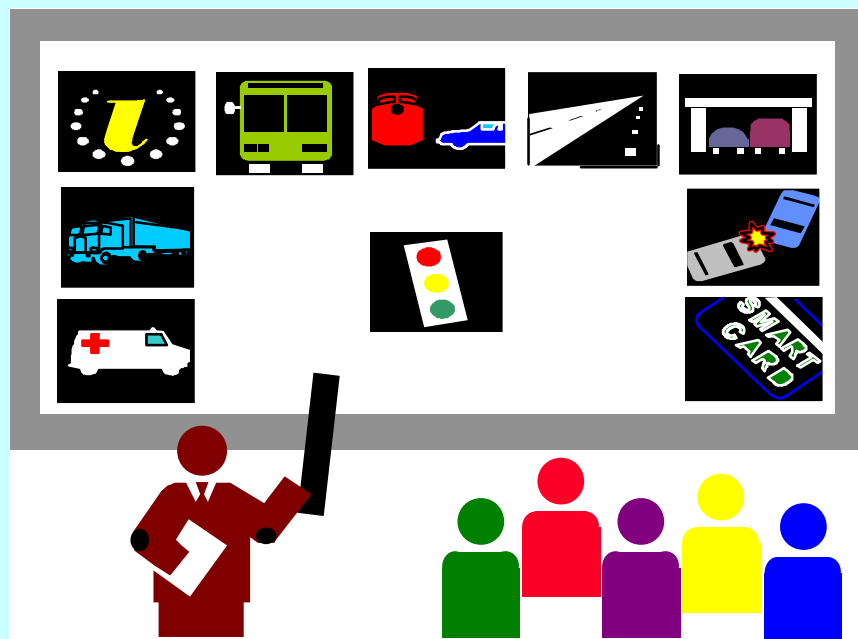


Building Professional Capacity in ITS:

Documentation and Analysis of Training and Education Needs in Support of ITS Deployment



**US Department of Transportation
ITS Joint Program Office
ITS PCB Program**

April 1999

FOREWORD

This report summarizes a comprehensive effort conducted in the summer of 1998 to more systematically investigate the intelligent transportation systems (ITS) training and education needs of transportation professionals. A team of analysts conducted a series of nearly 200 interviews in an effort to obtain a more detailed understanding of the underlying fundamental knowledge and skills required in support of ITS applications and services. The interviewees spanned a range of ITS involvement from those actively engaged for several years, to those just beginning the process. Thus, the reported needs reflect an important “grass-roots” perspective obtained from the public-sector, private-sector, and the academic community.

This report documents the wide-ranging ITS training and education needs of transportation professionals. An analysis of those needs resulted in the development of a PCB Program strategy to meet those needs both now and in the future. Although the focus of this work is ITS, the analysis also revealed that the fundamental knowledge and skills are applicable to a wider audience of transportation professionals engaged in the operation and management of multimodal surface transportation systems.

The ITS PCB Program is comprised of a partnership of organizations which work cooperatively to provide ITS professional capacity building. That partnership encompasses the public sector, the private sector, and the academic community. It is hoped that this report will be used as a foundation for ongoing dialogue with the multiple partners, stakeholders and transportation professionals everywhere about:

- The process of building professional capacity for ITS;
- The design and delivery of training and education programs that achieve the level of competency required for meeting the challenges of the 21st century transportation systems; and
- The most effective and cooperative programmatic ways to meet training and education needs.

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April, 1999

ACKNOWLEDGEMENTS

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- The Volpe National Transportation Systems Center (VNTSC)
- The Federal Transit Administration's ITS Program
- The Federal Highway's National Highway Institute (NHI) and Office of Personnel and Training.

The VNTSC project director was Suzanne M. Sloan, assisted by Mary Susan Sparlin of NHI. Key staff support from the Volpe Center was provided by Robert Brodesky, Joseph LoVecchio, Maureen Luna-Long, John O'Donnell, Douglas Rickenback, and Margaret Zirker.

The authors wish to thank the many individuals, located across the country, who took the time and made the substantial effort to arrange for the staff interviews that were so critical to the needs assessment. Also, thanks is gratefully extended to the nearly 200 interviewees and the training and education experts who were willing to be interviewed and whose excellent contributions of information and guidance have greatly benefited our work.

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READER'S GUIDE

SECTION I — INTRODUCTION

Section I presents the purpose of the report, the objectives of the needs assessment, and its importance to the ITS PCB Program. This section provides background information on the ITS PCB Program partnership. This section also briefly discusses the research methodology used to gather information for this report. Appendix A supports Section I with a more detailed discussion of the research methodology, a copy of the interview guide, and a profile of the interviewees and their locations.

SECTION II — FINDINGS AND ANALYSIS

Section II summarizes the findings and analysis of nearly 200 interviews, conducted in the summer of 1998, to discern the training and education needs of transportation professionals engaged in ITS planning, design, deployment, operations, maintenance, management, and evaluation. Using seven different types of transportation agencies as models that are engaged in twelve “typical” ITS projects and activities, Section II provides answers to three key questions:

- 1) *Who* needs to know about ITS? — Twenty “ideal” ITS roles are defined that are required throughout the stages of ITS planning, deployment, operations, and management.
- 2) *What* do ITS professionals (existing and new hires) need to know? — Interviewees provided insight into the underlying fundamental knowledge and skills (i.e., competencies) that are essential for ITS activities. The needs assessment helped identify the top ten competencies required for ITS deployment.
- 3) *How* are the knowledge and skills best learned? — Traditional classroom training has played an important role in providing training to transportation professionals. However, external constraints associated with limited time, travel funding, and a fast-paced business environment, give rise to the need for “training-on-demand.” The needs assessment helped to identify four categories of alternative delivery methods that can be used to build professional capacity for ITS. It also helped to identify the educational foundation perceived by today’s professionals as needed by the professionals of the future.

These roles, competencies and delivery methods are the three foundational building blocks of developing a tailored, targeted, and accessible PCB program. Section II also presents a discussion regarding some of the cultural and institutional factors that can either facilitate change or present an obstacle to it. These factors are presented because interviewees frequently stressed how they can influence the effectiveness and success of ITS professional capacity building.

SECTION III — PCB PROGRAM STRATEGY

Section III presents a program strategy and recommendations for meeting the ITS training and education needs of transportation professionals, now and in the future. This section is directed

specifically at the PCB Program and its partners on how to develop and deliver ITS professional capacity building.

APPENDIX A provides a more detailed discussion of the research methodology and profiles of the interview sites and their deployment activities.

APPENDIX B is a bibliography of the literature used in support of this needs assessment.

APPENDIX C describes in further detail, the specific action items that are needed to implement the recommendations provided in Section III. This appendix presents the action items according to a timeline, showing accomplished actions, actions underway, and future actions proposed for PCB partner organizations.

APPENDIX D is the report, *Building Organizational Professional Capacity in ITS: Guidelines for Staffing, Hiring, and Designing “Ideal” Project Teams*. This report uses two of the PCB building blocks — roles and competencies— to construct a set of staffing charts that describe the composition of “ideal” teams for ITS projects and activities to guide staffing and hiring decisions. It is also available as a separate report.

APPENDIX E is the report, *Building Professional Capacity in ITS: Guidelines for Designing an Individualized Training and Education Plan*. Again, using the ITS roles and competencies, this report presents a set of ITS curricula that recommend a course of learning for twenty ITS roles. It is also available as a separate report.

APPENDIX F is the report, *Building Professional Capacity in ITS: Guidelines for Developing the Future Transportation Professional*. This report assesses the needs of future transportation professionals and identifies actions that can be take by the academic community and others to develop future professionals. It is also available as a separate report.

OTHER SUPPORTING DOCUMENTATION

This report is supported by the following companion documents that offer the reader more information on building ITS professional capacity.

1) *An Assessment of ITS Training and Education Needs: The Transit Perspective*

This companion report provides the results of the in-depth needs assessment from a transit and FTA perspective. It is based on the same interviews and database used in this report, but focuses them on transit-specific findings. The current and recommended roles of FTA staff are also described. This report will be available in May 1999 and will be accessible on the PCB web page at:

<http://www.its.dot.gov/>

2) The Catalog of U.S. DOT's PCB Program Courses and Seminars

This catalog describes the seminars, courses, and workshops currently available, or soon to be available, on topics related to ITS planning, design, deployment operations, maintenance, and evaluation. The offerings are available to federal, state, local, and private sector practitioners and made available by four PCB Partners: (1) the U.S. DOT which includes FHWA, FTA and OMC, (2) the National Transit Institute (NTI) in conjunction with FTA, (3) the National Highway Institute (NHI) in conjunction with FHWA, and (4) the National Training Center (NTC) in conjunction with OMC. The majority of the course and seminar materials provided by

the U.S. DOT PCB program are available to local instructors who may wish to modify and present them to meet local needs. The catalog is updated quarterly and can be accessed on the internet at:

<http://www.its.dot.gov/pcb/98catalg.htm>

The schedule and location of course/seminar presentations can also be accessed at:

<http://www.nhi.fhwa.dot.gov/Schedule.cfm>

3) The Catalog of ITS Education and Training Efforts at U.S. Universities

This catalog lists ITS courses, certificate programs, and courses containing ITS content at universities around the country. It was developed by Virginia Tech in cooperation with the U.S. DOT's PCB Program and is available on the internet site:

<http://www.ctr.vt.edu/>

4) The Catalog of Private Sector/Vendor Training on ITS

This catalog, released in January 1999, describes training courses and seminars offered by the private sector. It was developed by ITS America in cooperation with the U.S. DOT PCB Program and is now available by searching the following internet site for professional capacity building:

[www. http://www.itsa.org/](http://www.itsa.org/)

5) *ITS Electronic Documents Library (EDL)*

The ITS-EDL is an electronic repository of documents on intelligent transportation system topics published by the U.S. Department of Transportation and can be accessed at:

<http://www.its.fhwa.dot.gov/cyberdocs/welcome.htm>

6) *Newsletter of the ITS Cooperative Deployment Network (ICDN)*

This electronic newsletter and shared internet resource provides a monthly status report on the major events in ITS. It is created and maintained by the National Associations Working Group for ITS (NAWG), a cooperative effort of organizations whose members are spearheading ITS deployment in the U.S. The newsletter includes up-to-date news, new insights, and resources for transportation professionals and agencies. The newsletter is provided monthly free of charge to anyone who registers for it. It can be accessed at:

<http://www.nawgits.com/icdn/>

The newsletter is emailed on the 15th of each month, and will include all items posted within the past 30 days. Occasional ICDN Special Alerts are issued when there's hot news that simply can't wait until the next regular newsletter. To sign up, simply access the above web page where there is a registration form and an option to "subscribe."

SECTION I — INTRODUCTION

SECTION AT A GLANCE:

— **Purpose of Report**

- ⇒ Exhibit I-1: Framework for Building ITS Professional Capacity
- ⇒ Exhibit I-2: Why PCB for ITS?

— **PCB Program Partnerships**

- ⇒ Exhibit I-3: PCB Program Partners

— **Research Methodology and Scope**

- Appendix A supports Section I with a more detailed discussion of the research methodology, a copy of the interview guide, and a profile of the interviewees and their sites.
- Appendix B, the bibliography, supports Section I with a listing of the literature used in support of the needs assessment effort.

SECTION I — INTRODUCTION

Over the last few years, the application of intelligent transportation systems (ITS) technologies and services to surface transportation has gained momentum. ITS employs advanced communications, information, and computer technologies to meet a number of strategic goals, including enhanced mobility of people and commerce, safety, and efficiency. Implementing ITS is a complex effort requiring the cooperation of many organizations and professionals within a locality, region, and state. As ITS grows in importance to the operation of surface transportation systems, so too grows the need to prepare existing and future transportation professionals to plan, design, deploy, operate, maintain, manage, and evaluate ITS effectively.

In 1996, the U.S. Department of Transportation (U.S. DOT) established the ITS Professional Capacity Building (PCB) Program — a partnership of public sector, academic, and private sector organizations — to enhance the capacity of transportation professionals, now and in the future, to develop and deploy ITS applications. In the summer of 1998, the U.S. DOT conducted a needs assessment comprising nearly 200 interviews with highway, traffic, and transit staff personnel in metropolitan areas to identify the specialized training and education needs of transportation professionals engaged now and/or planning to be engaged in future ITS deployment.

PURPOSE OF THIS REPORT

This report identifies the fundamental knowledge and skills required by transportation professionals to develop and deploy ITS effectively. It identifies how multiple partners, particularly those involved in the PCB Program, can provide the necessary training and education to enhance key competencies. As illustrated in Exhibit I-1, this report addresses three key questions:

- *Who* are the essential personnel working on ITS?
- *What* do these professionals (existing and new hires) need to know?
- *How* are the knowledge and skills best learned?

To answer these questions, the U.S. DOT conducted a needs assessment whose results also provided a basis for refining the strategy of the PCB Program. Based on the findings documented in this report, the challenge now is for the PCB Program partners to work on a concerted strategy to achieve the following objectives:

- Develop appropriate curricula and courses
- Deliver courses to as many professionals as possible
- Create a virtual and continuous learning environment
- Strengthen and expand the network of partners who build professional capacity for ITS
- Expand communications and outreach on the need for building professional capacity and on the availability of PCB resources

- Continuously improve the PCB program through measured progress, and mainstream the program's activities into established and ongoing training and education programs of its partner organizations.

The ultimate goal is for multiple organizations in the public sector, private sector, and academia to develop and deliver training, education, technical assistance, and information outreach on ITS that is:

- *Tailored* in content and job-relevant,
- *Targeted* to meet audience, and
- *Accessible* where, when, and as needed.

EXHIBIT I-1: FRAMEWORK FOR BUILDING ITS PROFESSIONAL CAPACITY

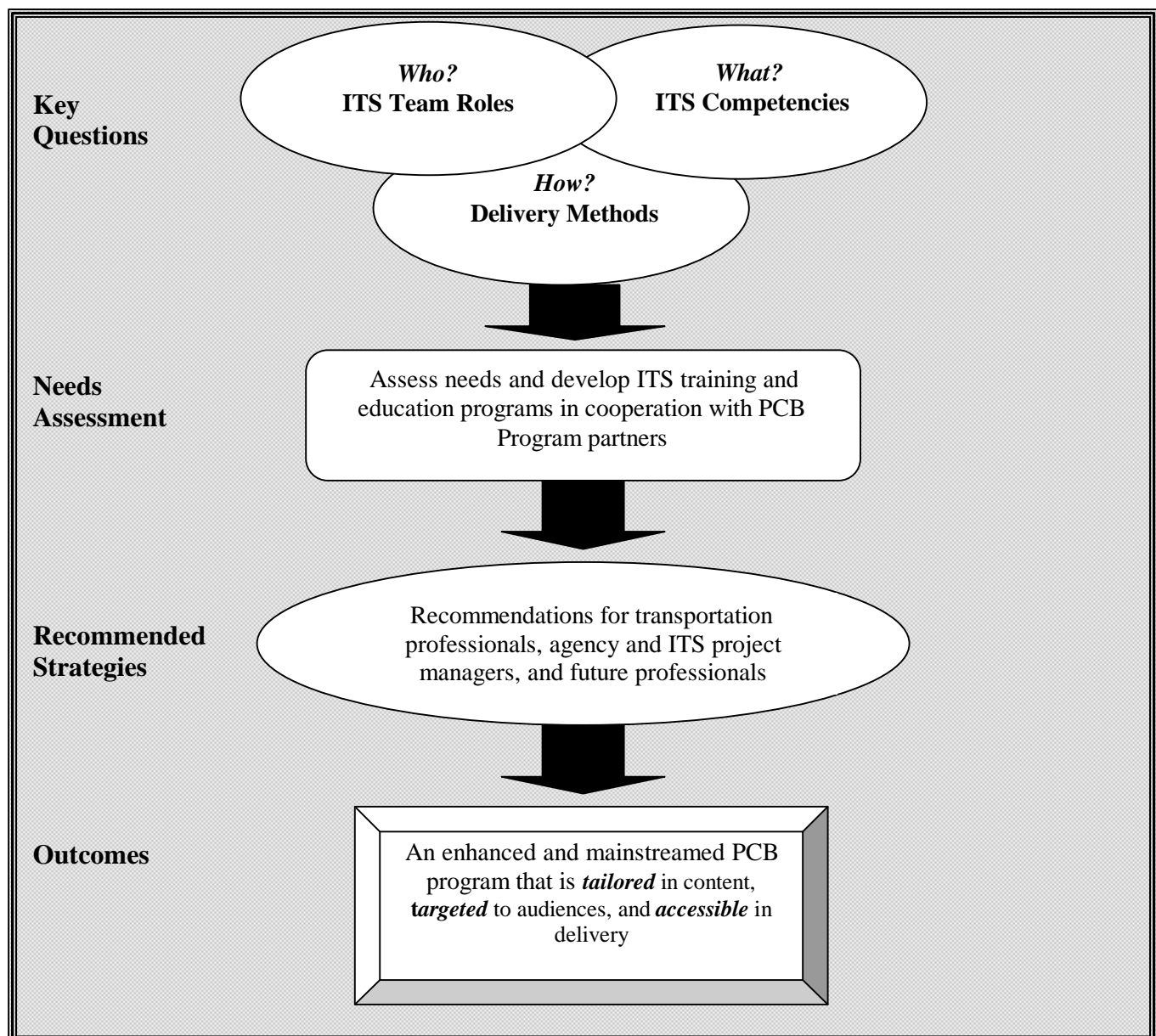


EXHIBIT I-2: WHY PCB FOR ITS?**Why PCB for ITS?**

The introduction of ITS services and technologies will broaden the focus of many public sector transportation agencies from the building and expansion of physical infrastructure to include the operation and management of existing infrastructure. This expansive focus will fundamentally change the functions and routines of transportation professionals whose daily job it is to support the flow of passengers and goods within regions and across the nation.

In particular, ITS deployment will require skills that venture beyond the borders of the traditional civil engineering knowledge of many of today's surface transportation professionals. Most roles require a deep technical understanding of information, communications, and computer technologies as well as the design and installation of new ITS technologies and applications and their integration within existing "legacy" systems. In addition, effective systems design and analysis are essential to ensuring the success of ITS deployment.

ITS will also require unprecedented cooperation between public sector agencies as well as the public and private sectors, necessitating new skills in partnering, contracting, and negotiations. In fact, many of these institutional competencies have proven to be critical. They tend to cut across the various deployment and operations stages. They are not traditionally taught as part of the transportation engineering curricula. In the long-run, if ITS is to be successfully mainstreamed into transportation practices and policies, transportation professionals will need be able to affect organizational and cultural change.

A list of the pressing technical and institutional challenges are presented below:

TECHNICAL:

- ITS requires knowledge and skills across a range of highly technical topics. It requires expertise in information, communications, electronics, and automation technologies and systems integration.
- ITS also requires more extensive use of basic computer and software skills such as spreadsheets, database systems, word processing, or internet applications.
- ITS deployment rests upon a foundation of multidisciplinary knowledge, skills, and abilities.
- Knowledge and skills must keep up with the continuous evolution of technologies and innovative practices.

INSTITUTIONAL:

- ITS frequently requires multi-agency, multi-discipline, and multi-jurisdictional teams of professionals working interdependently.
- ITS emphasizes operations, rather than capital improvement.
- ITS calls for greater cooperation and partnerships within regions.
- ITS often requires shared resources among agencies and innovative public/private partnerships and funding.
- Because of their relative newness, the public and key decision-makers must become aware of ITS services and their potential benefits.

THE ITS PROFESSIONAL CAPACITY BUILDING PARTNERSHIP

The primary audience for this report are the many stakeholders involved in building professional capacity for ITS, particularly the partners involved in U.S. DOT's ITS PCB Program. The PCB Program is a collaboration of many organizations, which bring different strengths and expertise to bear on building ITS professional capacity. The PCB partners are drawn from the private sector, the public sector, and the nation's universities to develop and deliver the comprehensive, national transportation training and education initiatives required to create the transportation professional of the 21st century.

EXHIBIT I-3: ITS PCB PROGRAM PARTNERS

PUBLIC SECTOR ORGANIZATIONS	ACADEMIC INSTITUTIONS	PRIVATE SECTOR ORGANIZATIONS
<ul style="list-style-type: none">• The ITS Joint Program Office• The U.S DOT ITS PCB Program• FHWA and NHI• OMC and NTC• FTA and NTI• ITS America (ITSA)• Non-profit professional associations• State and local programs• LTAP centers	<ul style="list-style-type: none">• Undergraduate degrees at universities and colleges• Graduate degrees at universities and colleges• Continuing education• Community colleges• Technical and vocational schools	<ul style="list-style-type: none">• Private sector training organizations• Vendors of ITS equipment• Consultants and corporations in the deployment, systems integration, and operations business• Professional associations with private sector membership

Public sector partners design and deliver training, technical assistance, and information outreach and dissemination programs. The public-sector effort has been led by the U.S. DOT's ITS PCB Program, which has relied heavily on the cooperative efforts of other public sector partners such as:

- The Federal Highway Administration's (FHWA) ITS programs and its training programs with the National Highway Institute (NHI) and the National Training Center (NTC), which provide training to FHWA and the Office of Motor Carriers (OMC) staff and state and local highway transportation professionals.
- The Federal Transit Administration's (FTA) ITS program and the National Transit Institute (NTI), which provides training to FTA staff and regional and local transit professionals.
- Non-profit organizations such as ITS America (ITSA), the Institute of Transportation Engineers (ITE), and Public Technologies, Inc. (PTI).

- FHWA's Local Technical Assistance Program (LTAP) centers, which provide transportation training and education to field staff.

The academic community includes universities, colleges, and vocational/technical schools who are incorporating ITS and ITS-related context into their courses and degree programs, and who also provide continuing education and technical training for professionals.

The private sector partners include training firms and professional associations whose memberships comprise many of the professionals working in surface transportation. These partners distribute ITS-related information to their members, provide training, and provide peer-exchange and networking opportunities through conferences, web-sites, and educational videos. Private sector partners also include consulting firms and vendors who provide professional capacity building through consulting, equipment training, technology demonstrations, and exhibitions.

NEEDS ASSESSMENT METHODOLOGY

In order to further the work of the ITS PCB Program, the U.S. DOT interviewed nearly 200 professionals working on ITS highway and transit projects by telephone and in person at ITS deployment sites in five metropolitan areas:

- Atlanta, Georgia;
- Minneapolis-St. Paul, Minnesota;
- Houston, Texas;
- San Francisco Bay Area, California; and
- Salt Lake City, Utah.

Additional research included four focus group meetings, two held in Washington, D.C., and two held at the ITE annual international meeting in Toronto, Canada, which included representatives from:

- Washington, D.C.;
- Phoenix, Arizona;
- Portland, Oregon;
- Menlo Park, California;
- the States of Maryland and Virginia; and
- consultants from multiple ITS deployment projects around the country.

Those interviewed spanned a range of involvement in ITS from several years of deployment experience to those who are just starting the process. Also, interviewees came from different types of agencies and from many different levels within their organizations. Since this effort focused primarily on metropolitan highway, traffic, and transit applications, the findings do not reflect the full range of needs in rural areas or by commercial vehicle operators.

The U.S. DOT team also conducted an extensive literature review to better understand ITS professional capacity building (bibliography listed in Appendix B), and reviewed the many

training and education resources that have been developed in response to known ITS needs. These resources were identified using the following sources:

- Research reports documenting ITS professional capacity building, by the U.S. DOT and PCB partner organizations.
- *The Catalog of U.S. DOT PCB Courses.*
- *The Catalog of University Courses.*
- *The Catalog of Private Sector Courses.*
- FHWA and FTA ITS programs for technical assistance, such as the Peer-to-Peer program or the Scanning Reviews.
- ITS Program information outreach conducted by the U.S. DOT and professional associations such as:
 - ⇒ The National Associations Working Group (www.nawgits.com) and its monthly electronic newsletter, the ITS Cooperative Deployment Network (www.nawgits.com/icdn/).
 - ⇒ ITS America (www.itsa.org) and its electronic newsletter Access ITS (www.itsa.org/home.nsf).
 - ⇒ Professional associations conferences such as ITE, ITS America, or American Public Transit Association (APTA).
- Web Sites of the universities who host ITS Research Centers of Excellence, and many other universities who conduct ITS research and have a dedicated website for ITS information.

SECTION II — ITS PROFESSIONAL CAPACITY BUILDING NEEDS: FINDINGS AND ANALYSIS

SECTION AT A GLANCE:

- **Who Needs to Know?— Identifying the PCB Audience**
 - ⇒ Exhibit II-1: Agencies involved in ITS Deployment
 - ⇒ Exhibit II-2: Ideal ITS Roles
 - ⇒ Example: Defining an ITS Role
 - **What do Professionals Need to Know? — Identifying PCB Content**
 - ⇒ Exhibit II-3: Top Ten ITS Training and Education Needs
 - ⇒ Exhibit II-4: Range of ITS Competencies
 - ⇒ Example: Identifying Requisite ITS Competencies and Curricula
 - **How are the Knowledge and Skills Best Learned? — Identifying Effective Delivery Methods**
 - ⇒ Exhibit II-5: Range of Ideal Delivery Methods
 - ⇒ Exhibit II-6: Comments on the Delivery Role
 - **Cultural and Institutional Factors**
 - ⇒ Organizational Change
 - ⇒ Staffing and Human Resources
 - ⇒ Policy and Legislative Reform
- Appendix D supports Section II by providing further detail on how the twenty “ideal” ITS roles can be used to effectively staff and/or hire teams to deploy ITS projects and conduct ITS activities. This appendix is also issued as a separate report entitled, *Building Professional Capacity in ITS: Guidelines for Staffing, Hiring and Designing Ideal Project Teams*.
 - Appendix E supports Section II by providing more detailed definitions of the ITS competencies and roles, and by using them to construct a set of twenty ITS curricula to provide guidance on learning for each role. This appendix is also issued as a separate report entitled, *Building Professional Capacity in ITS: Guidelines for Designing Individualized Training and Education Plans*.
 - Appendix F supports Section II by recommending competencies for developing the next generation of professionals. Using the findings presented in Section II, this appendix discusses the new and expanding needs of future transportation professionals at all levels of the industry. This appendix is also issued as a separate report entitled, *Building Professional Capacity in ITS: Guidelines for Developing the Future Transportation Professional*.

SECTION II — ITS PROFESSIONAL CAPACITY BUILDING NEEDS: FINDINGS AND ANALYSIS

Given the multi-modal nature and functions of surface transportation systems, agencies and individuals have a wide range of needs for enhancing their capabilities to develop and deploy ITS projects and programs. In addition, their capabilities to implement ITS technologies and services vary tremendously even within agencies. The interviews confirmed that transportation professionals are looking for ways to enhance their capacities to make ITS work for them. But they need education, training, technical assistance, and information that are *tailored*, *targeted*, and *accessible*.

From the needs assessment, twenty roles emerged as critical to the success throughout the planning, deployment, and operation of ITS. The interviews and survey data also identified the critical knowledge and skills required to plan, design, deploy, operate, maintain, manage, and evaluate ITS. Twenty-seven competencies (i.e., bundles of knowledge and skills applied to a specific topic) emerged as critical for developing and deploying ITS, in addition to understanding the technical ITS program areas such as advanced traveler information systems. Those interviewed were able to rank the competencies in order of criticality, enabling U.S. DOT to develop a “top ten” list of training and education needs.

Throughout the course of the interviews, one theme repeated itself again and again — the method by which professional capacity is built is as important as the content. Interviewees frequently requested “just-in-time” and “on-the-job” training, education, technical assistance, and information dissemination. Interviewees also provided advice about which organizations and agencies should provide ITS training and education.

Although interviewees were asked to focus on professional capacity required for ITS, the discussions revealed cultural and institutional issues that fell outside of the interview scope. Interviewees frequently discussed needs, such as changes in internal and external agency relationships or reform of state and local legislation. These concerns are reported in this section because interviewees stressed that these cultural and institutional factors could impede efforts to build professional capacity for ITS.

WHO NEEDS TO KNOW? — IDENTIFYING THE PCB AUDIENCE

There are a variety of roles and functions that are required to plan, design, deploy, operate, maintain, manage and evaluate ITS technologies and services. Being able to identify the roles people play is critical to understanding what competencies they need to perform effectively in their jobs, and at what level those competencies are needed (i.e., at an awareness or specialized level). Essentially, the “ITS roles” become a way of targeting specific audiences for training, education, and outreach, and for tailoring content appropriate to those audiences.

The following table presents seven types of agencies that are typically involved in ITS projects and activities. As identified by the interviewees, these agencies tend to be the dominant players in ITS. There are, however, agencies, firms, projects and activities not on this table — such as police and emergency agencies, and commercial vehicle operators — that are equally as significant to the planning, design, deployment and operations of ITS, but were not included in the scope of the needs assessment. In the near future, the PCB Program partners will investigate further the training and educational needs of these other critical ITS stakeholders.

Exhibit II-1: Agencies Involved in ITS Deployment

Transportation Agencies	Typical ITS Projects and Activities Covered in the Interviews
State Departments of Transportation (DOTs)	<ul style="list-style-type: none"> • Planning and Design Activities • Deploying, Integrating, Operating, Maintaining, and Evaluating ITS Infrastructure
Transit Agencies	<ul style="list-style-type: none"> • Deploying and Operating Transit AVL Systems • Deploying and Operating Transit Automated Trip Planning Systems • Operating Transit Data Management Systems
Metropolitan Planning Organizations (MPOs)	<ul style="list-style-type: none"> — ITS Outreach and Coordination Activities — ITS Planning and Mainstreaming Activities — ITS Awareness and Policy Activities • ITS Deployment Activities
Local City/County Departments of Transportation (DOTs), also known as Departments of Public Works (DPWs)	<ul style="list-style-type: none"> • Deploying and Operating Traffic Signal Control Systems
Transportation Management Centers (TMCs), the generic version of Traffic Operations Centers, Operations Control Centers, etc.	<ul style="list-style-type: none"> • TMC Operations using the ITS Infrastructure
Federal Transit Administration (FTA) Regional Offices	<ul style="list-style-type: none"> • ITS Education and Outreach • ITS Activities in Support of State and Local Agencies
Federal Highway Administration Resource Centers and Division Offices.	<ul style="list-style-type: none"> • ITS Education and Outreach • ITS Technical Assistance Activities in Support of State and Local Agencies

From the interviews, the following critical findings emerged:

- *Interviewees collectively identified twenty roles needed for ITS deployment.* Exhibit II-2 categorizes these twenty roles in terms of the stages of ITS development and deployment as well as cross-cutting roles. The roles should not be viewed as directly corresponding to staff positions. Rather, they imply important skill sets that should be brought to a project.

A more detailed description of each role appears in Appendix E, a report entitled, *Building Professional Capacity in ITS: Guidelines for Designing an Individualized Training and*

Education Plan. Appendix E also contains a curriculum designed to respond to the needs of each role.

Exhibit II-2: Ideal ITS Roles

<p><u>Roles needed for developing a Regional Concept of Operations and Planning for ITS</u></p> <ul style="list-style-type: none"> • Champions • Federal Field Staff • Planners <p><u>Roles needed for the ITS project stages: Design, Procurement, Installation, Operations and Maintenance, Management and Evaluation</u></p> <ul style="list-style-type: none"> • Project Managers • Software Developers • Systems Designers and Integrators • Operators • Dispatchers • Drivers • Electronics Inspection and Maintenance Technicians • Operations Managers and Supervisors 	<p><u>Cross-Cutting Roles</u></p> <ul style="list-style-type: none"> • Business Analysts • Data(base) Managers and Analysts • Contracts staff • Legal staff • Marketing and Public Relations staff • Human Resources staff • System and Network Administrators/Support Technicians <p><u>Creating Change: Roles for Mainstreaming ITS</u></p> <ul style="list-style-type: none"> • Program/Agency Managers • Inter-jurisdictional Coordinators
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- *Individuals frequently play more than one role as part of their jobs.* In the field, many of these roles are played by one person, or contracted out, for varying lengths of time, during the appropriate deployment stage. For example, in one city, a project manager provided marketing and public relations expertise while simultaneously managing an ITS deployment project.
- *For many of the roles, individuals have had little formal training or on the job preparation.* Many of the roles have evolved without specific staffing requirements in mind and no job descriptions.
- *Many roles require the same types of competencies, but at varying levels.* For example, planners, systems integrators, and maintenance technicians must all understand the National ITS Architecture and ITS Standards. However, some roles require only a basic level of awareness of the general framework while others require a specialized level of knowledge. For example, a specialized knowledge would require knowing how to integrate components through wireline and wireless media.

- The interviews revealed that, in deploying ITS, *the most effective performance resulted when the competencies were divided among a team of people*. In this respect, no one person has to know everything, which allows each team member to focus on those areas that are most important for their job responsibilities.
- *There was some consistency at sites as to which roles were contracted out versus kept in house*. Typically, the roles of project manager, traffic engineers, electronic maintenance, and systems support tended to be in-house, whereas the more technical roles in systems analysis, design, and integration tended to be contracted out. This was often a result of public agency hiring freezes or salary caps, and/or the lack of knowledge and skills in these technical areas on staff. However, staffing for these roles is not consistent within either public agencies or the private sector.

The following pages provide an example of an ITS role — an ITS Project Manager — as defined in Appendix E: *Building Professional Capacity in ITS: Guidelines for Designing an Individualized Training and Education Plan*. This report provides a similar definition for each ITS role identified in Exhibit II-2.

The following example presents a description and a bulleted list of the role's primary functions and responsibilities in ITS deployment. The roles are defined broadly, so as to be inclusive of private sector and public sector highways, traffic and transit personnel. However, if there are significant distinctions between the public and private sector roles, they are mentioned, as in the following example for project manager.

EXAMPLE: DEFINING AN ITS ROLE

Roles and Responsibilities of an “Ideal” ITS Project Manager

The role of the Project Manager is a primary and significant role in ITS deployment. It requires one of the more comprehensive ranges of breadth and depth in ITS competencies. Many of the interviewees played this role full-time; some were only part-time project managers, or had to employ project management skills in support of other deployment roles.

ITS Project Managers activities frequently begin in their role the planning and design stage of ITS projects, and continue through the selection of staff and contractors, procurement, deployment and installation activities. Some Project Managers begin in the Champion role, playing an instrumental part in the decision to deploy ITS. Others begin once the decision to deploy has been made by senior Program or Agency Managers. Once deployed and functional, Project Managers either transfer the working system to Operations Managers or become the Operations Manager.

ITS Project Managers must have a solid understanding of the transportation industry and the goals and functions of their agency. They must understand that deployed systems are expected to resolve, and a detailed knowledge of how to apply ITS technologies. They are responsible for ensuring that deployment is carried out effectively and successfully through staff and contractors, which requires an understanding of how ITS fits into the on-going capital improvement process and existing operations.

Functions and Responsibilities:

- Manage ITS project deployments from planning and design to operations, including:
 - Identify and involve all stakeholders in the system conceptualization and design, including other transportation agencies, non-traditional transportation agencies such as police, emergency and tow truck personnel, and other concerned groups.
 - Conduct/oversee user needs assessment as part of the design process; understand data needs and flows.
 - Involve non-traditional but necessary staff, and eventual users in the design and decision making, e.g., electronics technicians, operators, dispatchers, systems administrators and support staff, and external agency team members.
 - Determine the scope of the deployment using analysis tools such as investment analysis, impact analysis, or cost/benefit analysis.
 - Apply National ITS Architecture and Standards to project design.
 - Participate in technology selection and procurement; help prepare RFPs; determine technology and systems specifications.
 - Provide project oversight of software development; work closely with developers.
 - Staff/contract for and schedule project deployment activities; coordinate work with ongoing construction activities.
 - Select and manage contractors, their schedules and delivery milestones.
 - Secure financing/funding, manage grants, prepare budgets, track expenses.
 - Manage installation and integration, including prototyping, testing and evaluation stages.
 - Conduct periodic evaluations throughout the project cycle and lead final project inspection, testing and evaluation.
 - Design and plan for operations staff and support and maintenance staff.
- Ensure that the project is being deployed in tandem with other projects and assist with integration, including defining tests and performance measures that provide evidence of proper integration.
- Keep senior Program/Agency Managers informed of progress and engage their assistance for institutional/organizational or legislative changes.
- Work with Inter-jurisdictional Coordinator to account for impact on surrounding jurisdictions.

EXAMPLE: DEFINING AN ITS ROLE (CONT'D)

For the most part, the public and private sector Project Managers require similar competencies and backgrounds. Some of the more pronounced differences are:

- Private sector Project Managers are expected to have a more well-developed technical expertise in one or more of the competencies regarding information technologies, systems integration and engineering, telecommunications, or software development. It is assumed that most private sector Project Managers will have this technical expertise as part of their background.
 - Public sector Project Managers are expected to have a more well-developed institutional perspective, including agency management and organizational change, limitations to and management of public funds, a comprehensive understanding of the transportation system, and coordination of the ITS deployment with other ITS activities.
 - Private sector Project Managers must ensure that they and their staff have an understanding of transportation fundamentals, including vocabulary, traffic/transit engineering basics, and analysis of flow and capacity. They must be able to understand and meet contracted transportation goals and objectives and understand the statutory limitations of using public funds. Frequently, the private sector's lack of transportation experience creates a communications problem with public sector Project Managers, as does a similar public sector lack of experience with information technologies, systems engineering, and software development.
 - A contracted Project Manager is expected to have a solid level of commitment to the project to ensure that turnover does not hamper the deployment schedule, delivery milestones, or communications with the public sector client.
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What do Professionals Need to Know? — Identifying PCB Content

Professional capacity in ITS consists of developing new knowledge and skills. The knowledge and skills can be bundled to form competency areas — areas in which knowledge and skills are applied to a specific function or responsibility. Transportation professionals require these competencies as they move through the stages of ITS deployment: planning, design, installation (and testing), operations, maintenance, management and evaluation.

Competencies tend to be a combination of both technical and institutional knowledge and skills. For instance, technical knowledge and skills provide professionals with the ability to select the best technology options, manage contractors, or deploy systems that integrate data from other agencies. However, institutional knowledge is needed for using procurement options to select the best technologies and working across jurisdictional and organizational lines to leverage resources, among many other activities.

The following issues emerged during the interviews as critical findings for determining how to build competencies for ITS:

- *From a survey of the interviewees, the needs assessment developed a top ten list of critical ITS competencies.* This listing can be found on the following pages as Exhibit II-3. The top ten needs list was generated from all of the interviews and, therefore, represents the needs of the broadest audience of professionals working on ITS transit and highway projects in metropolitan areas. The top ten needs list can serve as an important guide for curricula and course development. Interestingly, although interviewees did not explicitly include the National ITS Architecture or ITS standards among their top ten needs, they did recognize the essential need to address systems integration and design. Therefore, it is important when developing training and education for the National ITS Architecture or ITS standards, to place these topics in the context of self-identified needs, such as systems integration or systems design.
- *It is important to tailor training and education for specific audiences.* For example, a project manager/operations engineer at a state DOT identified a need for non-technical, short, feasible explanations to promote his ITS projects to civic leaders and legislators. He noted that the PCB training materials could easily be tailored to meet this need and expressed an interest in their availability. “Top ten” competency lists were also developed for the seven different types of agencies, and can be found in Appendix D (the report entitled, *Building Professional Capacity in ITS: Guidelines for Staffing, Hiring, and Designing “Ideal” Project Teams*).

EXHIBIT II-3: TOP TEN ITS TRAINING AND EDUCATION NEEDS**Setting Priorities for ITS Professional Capacity Building: Top Ten Needs**

The required fundamental knowledge and skills for ITS are best captured by a survey conducted during the interviews (the survey is included in Appendix A) and analyzed using a relational database. The results of the survey produced a “top ten” list of ITS training and education needs that prioritizes ITS subjects that are of most consequence to field personnel.

- 1) **Systems Integration:** At the broadest level, interviewees use this term to describe the complex technical undertaking faced by linking individual transportation deployments and organizations together into a comprehensive regional transportation system. This topic also referred to interviewees’ experiences with or expectations about “plugging” technologies together.
- 2) **Organizational/Institutional Changes:** Adapting to change is an important aspect of building professional capacity. In one city, an agency planned to train its staff on a new automated system for use in a transit telephone-based itinerary planning department, through a course called “Coping with Change.” Interviewees also reported that professional must be equipped to overcome organizational and institutional barriers, such as narrowly defined mission statements that translate into rigid specification requirements; procurement, and contracting policy procedures that require lengthy review; as well as narrowly defined job classifications.
- 3) **Technology Options:** Interviewees cited the need to learn how to choose the most appropriate and cost-effective technologies to satisfy the greatest number of system users; to estimate both the costs and the benefits of the system; and to understand the capabilities, limitations, and risks of various technology options. Interviewees were also concerned about the life cycles, costs, and projected obsolescence of technologies. Interviewees especially expressed concern with receiving training on ITS technologies and systems once they were installed. Understanding end users is also essential. In one city, cameras were installed to enable monitor traffic at a traffic management center, but not provide film footage on TV broadcasts (which require different types of phone lines and cameras to produce quality needed for television). Yet the film ended up on the nightly news, when it was never intended for that use. Another case highlights an effective options analysis — a transportation division held a vendor fair, comprising four days of presentations from vendors, with no guarantees. This provided staff with a good idea of what was available and helped immeasurably when writing the specifications for their systems.
- 4) **System Analysis & Design:** This subject concerns the ability to define user needs (including identifying the users), and being able to design the network infrastructure and the software that operates the network in a way that meets those needs. For example, in one city, more than half way through the procurement of an advanced transit system, a non-technical project manager realized that linkages to other parts of the organization (scheduling and planning) as well as links to the oversight agency (the local lead agency) were not part of the package. She wished she had realized sooner how important this could be, and felt the vendors took deliberate advantage of her technical ignorance because including those links were the most difficult part of the design. She thought a questionnaire/checklist could have helped her. Also, she would have been willing to take a course because of the importance and cost of the project.

EXHIBIT II-3: TOP TEN ITS TRAINING AND EDUCATION NEEDS (CONT'D)

- 5) **Managing Contractors:** Interviewees spoke frequently about the misunderstanding and miscommunications between public agencies and contractors. Both public and private interviewees ascribe some of this to unfamiliarity with vocabulary and processes. Both are aware that problems frequently begin with the writing and interpretation of technical and/or functional specifications included in the request for proposals (RFPs), and perpetuate throughout the development of detailed contract documents unless expectations are precisely understood. One engineer conveyed that construction contractors often do not have the correct background or training for ITS installations. On one project, a roll of fiber optic cable fell off a truck and the contractor planned on installing it anyway. He had no idea that fiber optic cable is fragile glass that can break upon impact. A State DOT traffic management engineer observed that the various groups within his agency — such as consultant services, construction, and procurement people — did not have the understanding of the technology basis of the bids. They needed to know things like how to require an “acceptance” period; what to do when signals work but the interfaces don’t; low bid is not the only selection criteria and that software features and related support are more important; warranty periods need to be longer; training for maintenance needs to be more extensive.
- 6) **Financing:** This subject concerns both the availability of funding as well as the limitations of projects funded by grants. It also includes the issue of how to leverage scarce resources to realize project goals.
- 7) **Writing/Communications:** This includes both verbal and written clarity, particularly between the public and private sectors. Interviewees emphasized that their most important need was in writing specifications. Both public and private sectors discussed the importance of distinguishing between functional and operational requirements versus simply specifying technological options. Many interviewees spoke of their desire to have “verbal technical writers” on their project teams.
- 8) **ITS Planning and the Regional Concept of Operations:** The definition of this subject is focused on more effective management of the existing transportation system. Interviewees spoke about how metropolitan areas continue to be committed to increasing capacity and improving the overall safety and performance of the system. They identified this subject as including the shift from construction to alternative solutions, some of which incorporate advanced technologies. Regional planning and partnering is particularly difficult for the maintenance end of the project. Often, maintenance staff are not included in the planning stages. One state DOT is developing a new process, with policies and procedures, for any future ITS projects to insure all relevant staff are included.
- 9) **Coalition Building with New Stakeholders:** Interviewees stressed the importance of this consideration for any regional effort — learning how to build and maintain consensus is key to successful deployments.
- 10) **Data Analysis & Management:** Interviewees revealed that agencies that implement ITS are soon overwhelmed with the large amount of information available to them. Key concerns were the analysis, evaluation, and management of the information, especially as it applied to systems operations and customer satisfaction programs. One transit manager expressed being overwhelmed with what to do with the data — what kinds of reports to request; how to analyze the data to make management decisions; how and where to distribute the data.

- The interviews helped to identify essential competencies for ITS. Each ITS competency is defined in more detail in Appendix E, which is the report entitled, *Building Professional Capacity in ITS: Guidelines for Developing an Individualized Training and Education Plan*. Appendix E also includes a resource guide that identifies the available training and education for each competency area.

EXHIBIT II-4: RANGE OF ITS COMPETENCIES

(The top ten ITS training and education needs are noted in parentheses.)

<p><u>Competencies needed for developing a Regional Concept of Operations and Planning for ITS</u></p> <ul style="list-style-type: none"> • ITS Awareness/ITS Specific Topics • Identifying Stakeholders/Building Coalitions (9) • National ITS Architecture • Partnerships • Financing (6) • ITS Planning (8) <p><u>Competencies needed for the ITS project stages: Design, Procurement, Installation, Operations and Maintenance, Management and Evaluation</u></p> <ul style="list-style-type: none"> • Systems Analysis & Design (4) • Technology Options (3) • ITS Standards • Software and Hardware Operations • Software Development • ITS Human Factors • Procurement • Managing Contractors (5) • Systems Integration (1) • Project Evaluation • Operations • Systems Support and Maintenance 	<p><u>Cross-Cutting Competencies</u></p> <ul style="list-style-type: none"> • Project Management • ITS Legal Issues • Marketing/Public Relations • Writing/Communications (7) • Problem Solving • Data Analysis & Management (10) • Transportation Fundamentals <p><u>Creating Change: Competencies for Mainstreaming ITS</u></p> <ul style="list-style-type: none"> • Legislative and Policy Change • Organizational/Institutional Change (2) <p>► <u>ITS Specific Topics</u></p> <ul style="list-style-type: none"> • Freeway Management Systems • Incident and Emergency Management Systems • Advanced Traveler Information Systems • Advanced Public Transportation Systems • Advanced Traffic Signal Control Systems • Electronic Fare Payment Systems • Electronic Toll Collection Systems • Highway-Rail Intersection Systems • Commercial Vehicle Operations/CVISN • Rural ITS systems
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- *Each competency is a combination of both technical and institutional knowledge and skills.* The level at which they are needed is dependent upon the person's role, and crosses the spectrum from awareness to specialized. For example, the third most critical competency mentioned throughout the interviews was that of understanding ITS technology options. This competency breaks down into the following combination of knowledge and skills:

Technical knowledge and skills are needed for selecting the best technology options:

- An understanding of the *range of options* available.
- An understanding of the technologies' *performance capabilities*.
- An ability to *write the proper specifications* into the RFP or contract.
- The ability to confirm that the manufacturer's *QA/QC or Acceptance Testing* results are valid .
- An understanding of the *maintenance procedures and issues* involved with the selection.
- An ability to *maintain the technologies*.
- An understanding of *electrical engineering and electronics*.

Institutional knowledge is needed for using procurement options to select the technology that best meets the needs and working across agencies:

- An understanding of the *benefits of the technologies* and the *ability to communicate* those benefits to decision makers.
- An understanding of the *level of training* to request as part of the procurement, along with which *operations and maintenance guidebooks*.

- *The interviews revealed a need, by interviewees, to understand the sequence of learning for ITS.* Using the ITS roles and ITS competencies, model “curricula” were developed to assist individuals in achieving the recommended competencies. They will be tested with transportation professionals for reasonableness.

The ITS curricula, presented in Appendix E, are designed around U.S. DOT training and education courses and seminars, including those developed by the ITS PCB Program, the National Highway Institute, the National Transit Institute, ITE and ITS America. The curricula provide a sequence for learning at two levels — an **Awareness Level** which provides training to acquire knowledge at an awareness and overview level, and a **Specialized Level** that provides knowledge of the theoretical principles involved in ITS as well as “how-to” instruction for skill building.

- *Cross training and multi-disciplinary training is essential.* A principle engineer at a traffic management center cited the need for cross training on his staff. He had both the computer science expertise from college students and the electronics expertise from 2-year associate degree professionals, but still needed them to learn from one another to be the most effective. He also found having an educational cooperative exchange with the local university to be an effective recruiting and training opportunity.
- *Many of the topics are not uncommon to transportation projects and operations in general.* However, ITS adds a level of complexity that makes these issues more apparent, and in some

cases, more important to resolve. For example, the head of a systems engineering group at a transit system, found that a dual career path in both managerial and technical areas would be beneficial. A sabbatical to send these individuals back to school to update their skills in both business and the latest technologies would be very useful. “If people are given leave for jury duty, or military service,” he asked, “then why not for continuing education?” For the new engineers on the job who are promoted to managerial or supervisory jobs, they do not understand basic business fundamentals. They need to know how to perform cost/benefit analyses, prepare budget proposals and make decisions on “return on investment” criteria. As a result, it’s important to mainstream ITS content within existing traditional training and curricula.

- The professionals interviewed *cited many technical and institutional factors that exist within their environment that present barriers to successful deployment and limit the effectiveness of professional capacity building efforts*. These barriers include the need for organizations to change their culture, for instance, to allow for and reward teamwork and interagency cooperation.

Continuing with the role of the ITS Project Manager, the following pages present an example of the how competencies are recommended at the awareness and specialized levels, and how a curriculum can help a newly appointed Project Manager build a solid foundation in ITS competencies. A similar curriculum has been developed for each ITS role and is presented in Appendix E, *Building Professional Capacity in ITS: Guidelines for Designing an Individualized Training and Education Plan*.

EXAMPLE: IDENTIFYING REQUISITE ITS COMPETENCIES AND CURRICULA

ITS Project Managers at State DOTs

The following competencies are recommended to build the breadth and depth required for ITS Project Managers at State DOTs. The top ten competencies are noted in bold. Also, this example presents the ITS curriculum for the ITS Project Manager to build the ITS professional capacity needed to fulfill the role's functions and responsibilities, as outlined previously.

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Systems Analysis and Design (4) ITS Planning (8) Data Analysis and Management (10) National ITS Architecture ITS Standards Software Development Software and Hardware Operations ITS Human Factors ITS Legal Issues Marketing/Public Relations	Organizational/Institutional Change (2) Technology Options (3) Managing Contractors (5) Financing (6) Writing/Communications (7) Identifying Stakeholders/Building Coalitions (9) Project Management Procurement Project Evaluation Transportation Fundamentals Partnerships Legislative and Policy Change Problem Solving Operations

Using the Project Manager's competency recommendations in the box above, the curriculum presented on the following page can be established. The following symbols are used:

- P** Denotes specific ITS courses developed by U.S. DOT and its partners in the ITS PCB Program and offered by U.S. DOT, NHI, NTI, ITE, and ITSA. It also denotes relevant reports that can be found on the ITS Electronic Document Library (EDL) web site: (<http://www.its.dot.gov/welcome.htm>).
- *** Denotes suggested general training and education courses that have been identified as available through universities, vendors, professional associations, and/or available through the general U.S. DOT training program.
- Recommends courses that have not been identified as available. These courses may already exist or may need to be developed. These courses also act as suggestions for PCB partners seeking to develop new and relevant ITS training or education.

EXAMPLE: IDENTIFYING REQUISITE ITS COMPETENCIES AND CURRICULA (CONT'D)

The Project Manager provides an example of a more complicated curriculum, given both the breadth and depth they require for their role. The recommended core training and education for Project Managers**:

Awareness Training	P ITS Awareness Seminar (NHI, internet: http://www.nawgits.com/nawg/itsaware/)
	P An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)
	P Deploying Integrated ITS — Metropolitan (NHI, internet: http://www.its.dot.gov/pcb/deploygd.htm)
	P Deploying Integrated ITS — Rural (NHI)
	P ITS Software Acquisition (NHI)
	P NTCIP and ITS Standards — What Do They Mean for You? (ITE)
	P ITS and the Transportation Planning Process (NHI)
	P ITS Public/Private Partnerships (NHI)
	P ITS Telecommunications Overview (NHI)
	P Operating and Maintaining ITS (ITE)
	P Lessons Learned in ITS Procurement (NHI)
	U Courses on the software development process (U.S. DOT, vendors, universities)
	U Courses on software integration (vendors, universities)
	U Courses on systems engineering, installing and integrating hardware and software (vendors, universities, technical/vocational schools)
	U Courses on project management (U.S. DOT, universities, junior colleges)
	U Courses on data management and databases (universities)
	U Courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	U Courses in public sector financial management: contracts, cost/benefit analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	U Course in marketing/public relations basics (universities, junior colleges)
Specialized Training	P Using the National ITS Architecture for Deployment — Public Sector (U.S. DOT)
	P Standards Training Modules (U.S. DOT)
	P Advanced Transportation Management Technology Workshop (FHWA)
	P Managing Systems Integrators (ITSA)
	P Shared Resources for Telecommunications (NHI)
	P Planning the Integration of Transit and Traffic ITS Applications (NTI)
	ITS Topic Specific:
	P Freeway Management Systems (NHI)
	P Incident and Emergency Management Systems (I-95)
	- Advanced Traveler Information Systems
	P Advanced Signal Control Systems (NHI)
	- Electronic Toll Collection Systems
	- Highway-Rail Crossings
	Advanced Technology Options:
	P Video Communications Systems (vendor)
	P Traffic Surveillance Systems (ITSA)
	P Traffic Control Software and Signalization (NHI)
	P Computerized Traffic Signal Systems (NHI)
	P Advanced Traffic Signal Controllers (NHI)
	P HOV Facilities (NHI)
	P Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT)
	- Other models as they become available
	U Advanced course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	U Advanced course in negotiations (U.S. DOT, universities, professional associations)
	U Advanced course in procurement and legal issues (U.S. DOT)
	- Workshop in writing ITS contracts and specifications
	- Workshop in ITS legal issues

(** Many of the checked (✓) courses will be available on the PCB web page - <http://www.its.dot.gov> - as of Summer 1999.)

HOW ARE THE KNOWLEDGE AND SKILLS BEST LEARNED? — IDENTIFYING EFFECTIVE DELIVERY METHODS

Interviewees identified the need for PCB delivery to meet the criteria of accessibility and timeliness for general learning as well as specific “how-to” problem-solving needs. The need was frequently expressed as having professional capacity building “just in time” and “on the job” or “at the site” throughout the interviews. The interviewees themselves recommended delivery across a range of innovative methods that better fit their idea of how and when learning is needed.

Because of these needs, the definition of ITS professional capacity building was expanded to include other forms of delivery beside traditional training and education methods. The new definition encompasses methods that can be classified into four categories: training, education, technical assistance, and information outreach or dissemination.

Exhibit II-5: Range of Ideal Delivery Methods

Method	Objectives	Delivery Options
Training	Targets the development of specific knowledge or skills to support “today’s jobs”	<ul style="list-style-type: none"> • Traditional classroom • Computer-based training • Satellite broadcast of courses • Job rotation or exchange programs through/with agencies, professional associations, or private sector firms
Education	Provides fundamental principles and knowledge	<ul style="list-style-type: none"> • University and college semester courses, labs, and degree programs • Certificate programs for continuing education • Technical and vocational school courses, labs and degree programs • Apprenticeship/internship programs
Technical Assistance	Provides “hands-on” learning aimed at solving specific problems	<ul style="list-style-type: none"> • Mentoring • Scanning Reviews • Peer-to-Peer Network • Assistance from Federal Field Staff • Consultant/Contractor assistance
Information Outreach and Dissemination Programs	Enhances awareness of topics and resources	<ul style="list-style-type: none"> • Web site with reports, information and technical assistance • Papers with best practices, lessons learned, and successful approaches • Vendor sponsored programs: displays, exhibits, training • Electronic data libraries • Electronic newsletters

Interviewees frequently cited the importance of delivery methods in building professional capacity for ITS:

- *Frequently, practitioners do not need formalized training or education in response to a specific question or to address a specialized need.* Simply stated, they need to know the right information, at the right time, from an accessible place as quickly and conveniently as possible. Thus, practitioners said that professional capacity building methods need to expand beyond training and education to include technical assistance and targeted information dissemination programs.
- *In particular, the interviews revealed a very high demand for increased technical assistance.* Interviewees overwhelmingly preferred this type of help to "classroom training," feeling that it was much more effective and provided a more personalized and deeper approach to the issues. In particular, interviewees in operational roles wanted expanded opportunities for technical assistance. The Peer-to-Peer program and Scanning Reviews — consistently mentioned federal programs — were highly praised for their ability to transfer knowledge and skills in an effective way. They helped people better carry out their jobs, see the range of what is available and how it is applied. In addition, it provided a means for people to talk to their peers about common experiences.
- *Interviewees requested access to education, training, technical assistance, or information that will satisfy their need while the need is current.* Interviewees want information and learning to be available on demand. Following the recent rounds of downsizing, professionals find themselves even less able to take time to participate in off-site or lengthy training. Tight project schedules and the shortage of trained or qualified staff also contribute to a need for immediate access to information that often runs counter to existing educational methods. The traditional 'classroom' medium is appropriate for many situations, but today's professional have requirements that may best be filled by other media that complements the traditional classroom medium. These include computer-based training, satellite broadcasts, videos, and such other innovative media. In one interview, a project manager, who was writing an RFP for trip planning software, wished for a web site with a listing of critical issues to consider.
- *Professionals desire to learn from their peers who have already experienced the processes and challenges they are about to face.* In particular, interviewees expressed a desire for a more extensive focus on technical assistance programs such as the Peer-to-Peer Program and the Scanning Reviews, but at a level closer to actual deployment activities as opposed to senior level awareness. Many of the highly successful ITS professionals were self-taught. They learned by contacting other peers, going on scanning reviews, and learning on their own time. One interviewee spent a day of her vacation visiting TMC facilities in another state. She commented that she learned more in that one afternoon than she had in numerous conferences and courses. Mentoring or job exchange opportunities should be provided. They want to discuss their problems and consult with fellow practitioners, rather than from an academic setting or background. Practitioners who had accessed existing technical assistance programs related the value of being able to see, touch, and experience the operations of deployed systems, as well as to interact with their experienced peers to discuss processes, lessons learned and best practices. Interviewees requested an expansion of

technical assistance programs to include more innovative efforts such as job exchanges or mentoring programs.

- *Professionals want training that is accessible, but access means different things to different people.* For a project manager of transit operations in a northern state, accessible meant having training near a major airline hub, or within easy driving distance of her work location. She gave as an example a large metropolitan area Chicago which is regionally accessible versus a rural area where a conference was held because accommodations were cheaper, although it was very time consuming to reach. For a transportation electrical superintendent it meant being able to go directly to prints, plan designs, operations manuals, or a maintenance troubleshooting plan immediately when a device failure occurred. He wanted information at his fingertips, a need that an Internet clearinghouse site would serve particularly well.
- *Not surprisingly, the method of delivery and the preferred media vary based on the content, information, or skills to be transferred.* For example, most interviewees believed that the fundamental principles of software development or systems engineering should be taught in a university setting. However, a short video presentation describing project benefits may be all that is necessary to keep high level executives informed.
- *Interviewees requested a central clearinghouse that would include an easy search engine with access to successful approaches, best practices, examples, checklists, lessons learned, and benefits.* Rather than not knowing enough about useful learning tools, interviewees spoke of the information overload of reports, brochures and the like that are not targeted to meet job relevant needs. While the demand for information is high, it must be delivered effectively and in a timely manner. One interviewee said:

"I wish there was a web site that would maintain an updated list all of the Freeway Service Patrols in the country with contact numbers. We are always wondering who else has done this or that. Finding up to date information is difficult."
- *Interviewees found that education was most effective for learning the fundamental principles about a topic.* The analysis of the top ten competencies can be used to design academic courses that better equip the "future transportation professional" and provide job-relevant continuing education to existing professionals. This means that traditional transportation studies will need to expand beyond traditional civil engineering basics to incorporate topics such as systems engineering, telecommunications, business, software development, political, and verbal and written communication skills. While engineering curricula are already very intense, lectures or exposure to these newer topics are essential to providing a "complete" transportation education.
- *Interviewees had strong opinions about what works best and why, including issues such as the credibility of deliverer, their ability to answer questions with authority, and their experience.* These comments are summarized in Exhibit II-6

EXHIBIT II-6: COMMENTS ON THE DELIVERY ROLE

Agency	Role in Delivery of ITS PCB
U.S. DOT	<p>Interviewees said there is definitely a role for the U.S. DOT to play in ITS professional capacity building. There were many components to this role:</p> <ul style="list-style-type: none"> • Interviewees felt that U.S. DOT (headquarters and field staff) were uniquely situated to present courses covering policy and funding issues. • Interviewees recognized and appreciated the federal role in providing funding for course attendance. • The federal capability to develop and deliver courses that could not be developed by smaller agencies. • There was a general consensus that U.S. DOT should continue to fund special programs and projects such as the Peer-to-Peer Program, scanning reviews, and FHWA's technology trailer and OMC's technology truck.
Universities, Colleges, Vocational and Technical Schools	<p>Interviewees felt that universities have a role in providing training and continuing education for transportation professionals:</p> <ul style="list-style-type: none"> • Many provided examples of training programs that support their agencies, such as the TMC operators program at San Luis Obispo in California. • Interviewees also provided insight into how universities could shift their focus to changing industry needs. For example, decision makers who hire staff desire more technically-grounded, systems-oriented new hires from both university and college engineering programs and technical and vocational school technicians programs.
Private Sector Training	<p>Interviewees discussed the role of commercial firms that provide technical training, vendors who provide equipment and maintenance training, and consultants who may be hired to provide specialized training. They noted that these sources usually are the best choice for very specialized or technical needs:</p> <ul style="list-style-type: none"> • One agency found a way to require training as a stipulation in their procurement contract. Agency staff could then receive "official" manufacturer supplied and certified training to maintain the new equipment. • Another agency required combined training classes where agency staff were trained alongside consultant staff, thus assuring that both partners in the project had equal knowledge. • Public sector interviewees worried about the use of consultants and competitive issues. However, most felt that consultants frequently had more advanced understanding of the technology.

EXHIBIT II-6: COMMENTS ON THE DELIVERY ROLE (CONT'D)

Innovative Suggestions	<ul style="list-style-type: none"> • Mentoring or job exchange opportunities should be provided. • Many professionals read journals, go to conferences, and join ITS America committees or committees of other professional associations. This is frequently possible at the project manager level and above. However, other positions, especially at the technical level, have limited opportunities to pursue activities off-site. "Typical" staff do not go to TRB or other large conferences. There was a great deal of interest in programs that would provide opportunities for people "the next level down" to visit "key" or model operational sites. • Because peer to peer was considered the best form of education and knowledge exchange, numerous suggestions were made regarding the creation of an electronic "rolodex" of peers and experts, segmented by region and ITS project. • Another innovative suggestion, from quite a few interviewees, was the creation of job exchange programs within professional associations or with the local MPO aiding in the exchange. Also, federal interns rotating through local agencies would give them valuable experience when overseeing grantees in the future.
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CULTURAL AND INSTITUTIONAL FACTORS

The process of building professional capacity — identifying essential roles, developing curricula and courses, and delivering training and education through accessible media — does not take place in a vacuum. Professional capacity building activities can introduce change, albeit positive, in the staff and the workplace by introducing new knowledge, skills, and ways of doing business. As such, agencies embarking on the path of building the capacity of transportation personnel must grasp the cultural and institutional factors that can either facilitate positive change or stand in its way.

The needs assessment uncovered a number of cultural and institutional that factors influence the effectiveness of professional capacity building. In particular, interviewees identified four categories of concerns:

- Organizational Change
- Staffing and Human Resources
- Contracting and Procurement
- Legislative and Policy Reform

Organizational Change

Interviewees indicated that ITS deployments require an organizational culture, or climate, where the following exists:

- Openness to change, implemented with the full support of decision-makers and management;

- Institutionalized values and shared attitudes among employees;
- Teamwork and cohesion among employees from different departments and external agencies;
- Openness to new technologies or strategies;
- An atmosphere where "risk-taking" is permissible (organizations can consider solutions or technologies that are not "tried and true"); and
- An interest in delivering improvements that continuously meet "customer" needs.

Interviewees found that changes such as these tend to occur more readily and successfully with the emergence of a champion or an advocate (such as a legislator or senior level manager) who can:

- Provide a vision;
- Is willing to campaign among decision-makers and work with legislators and the business community;
- Can recognize that their success requires good public relations initiatives, so that the public understands the benefits of the technology; and
- Can establish a long-term strategic direction, provide day-to-day direction, and redirect funding to support ITS planning and deployment.

Staffing and Human Resources

Interviewees called for the adoption of human resource practices that are more in tune with the technical developments, the competitiveness of the job market, and the service demands of customers. Specifically, they called for:

- Creation of job classifications and descriptions, that enable them to hire individuals with computer science, electrical engineering, system development and integration, and database management skills;
- Adoption of competitive pay scales and compensation packages that enable them to recruit individuals who are fresh out of undergraduate and graduate programs, attract individuals who are mid-career with technological expertise, and retain valued employees;
- An educational and training strategy that caters to mid-career employees who are searching for on-the-job challenges; and
- Human resource professionals who understand the technical requirements of the new class of positions that are needed, and are able to follow through with an effective recruitment strategy.

Contracting and Procurement

Two areas were of particular concern — (1) standard procurement and contracting procedures, and (2) partnerships. Interviewees consistently stated that deployment of ITS projects depended upon significant modifications to the standard procurement and contracting procedures that have

been employed by their organizations. The procedures or practices need to be modified to accommodate:

- Extensive on-site problem-solving, provided by a range of technical experts;
- The use of functional specifications, which facilitate problem-solving and use of the most current technology;
- The creation of partnerships among public agencies and with private sector organizations that are based on contractual agreements regarding:
 - risk sharing
 - continued cooperation following prototyping and deployment
 - ownership of intellectual property and data, and
 - maintenance of hardware, software, and systems; and
- The rapid changes that are occurring in the communication and information technology markets, where product life cycles are lasting no more than 12 to 18 months. One interviewee noted that by the time responses to his RFPs were in and the contracts awarded, the technology described in the RFP was obsolete, necessitating the time and cost of immediate change orders.

In particular, interviewees indicated that the complexity of ITS programs has made it necessary for their organizations to begin employing different procurement strategies. For example, an agency moving forward with a deployment must decide whether to assign contracts to the best qualified contractors/consultants or to contract with a consortium of contractors, which would create the responsibility for bringing the "right" players together and coordinating their participation.

Often low-cost bid procurement is not the most effective method for meeting the needs of ITS technology purchases. For example, software procurements must consider compatibility and extendibility. Contracting with the lowest cost provider could result in the acquisition of technology that is out-of-date. In addition, the selection of the low-cost provider sometimes excludes value-added services — access to troubleshooting help, hardware and software updates, maintenance support — that are essential for the continued well-being of the ITS application.

Policy and Legislative Reform

Interviewees frequently spoke of state and local policies that impede ITS development and deployment activities. In order for professional capacity building to be effective, certain policies were highlighted that require change. Many of the interviewees who are actively involved in ITS deployments stated that their ability to move forward has been hampered by a lack of awareness or buy-in among decision-makers, and the need for new statewide legislation (and public policy), which enables agencies to modify operating and business practices.

Given that many ITS-related programs are multi-jurisdictional and require shared responsibility, a great need exists for public agencies to form partnerships with other agencies, as well as private sector organizations. Moving forward with partnerships that permit a sharing of

responsibility, particularly the risks and rewards associated with development costs, has not always been possible without modification to a state's constitution or the passage of new legislation. Consequently, participants from the public and private sectors must understand upfront what legal restrictions might exist at the federal, state, and local government levels. Interviewees called for changes in policies to:

Foster legislation which:

- Enables agencies to acquire the intellectual property rights of software and technology that have been developed on their behalf.
- Simplifies the process for agencies to:
 - form partnerships with other public organizations, as well as private enterprises,
 - jointly own and operate technology,
 - establish protocols for sharing and transmitting data, and
 - arrange for cooperative purchases.

Promote recognition among policy-makers that:

- Selecting a consultant, contractor or vendor based on price alone is not always in the public's best interest. Other criteria, such as value-added services, need to be heavily considered. Value-added services include a provider's commitment to a continuing level of support and to troubleshooting problems following deployment.
- Considering functionality (along with the acquisition and application of technology) when developing a deployment strategy will result in more effective, and longer lasting solutions, particularly since technology is advancing at a rapid pace.
- Unlike highway, road, or transit construction projects, there is no established recipe for each stage of deployment for ITS. There must be sufficient latitude in each of the stages (planning, design, and implementation) for problem solving, troubleshooting, and testing of cutting-edge technology.
- Public agencies must begin to work cooperatively and continuously to implement technology, conduct evaluations, make performance-based decisions, and leverage procurement.
- There needs to be a greater commitment to the operations and maintenance functions of the transportation agencies. Without a local funding source, such as a dedicated sales tax, many operating agencies (particularly transit) are unable to move beyond the maintenance of day-to-day operations, and initiate more cutting-edge efficiency projects. Instead, the current financing of the day-to-day operations, equipment maintenance, and deployments of new technologies are heavily dependent upon the availability of federal grants.

SECTION III — PCB PROGRAM STRATEGY

SECTION AT A GLANCE:

— The PCB Program Strategy

- 1) Develop Curricula and Courses
 - ⇒ 1a) Curricula Development
 - ⇒ 1b) Course Enhancements
 - ⇒ 1c) Course Development
- 2) Deliver Courses
- 3) Create a Virtual and Continuous Learning Environment
 - ⇒ Exhibit II-1: What is a PCB Virtual Learning Environment?
- 4) Expand and Strengthen the PCB Partnerships
- 5) Expand PCB Communications and Outreach
- 6) Continuously improve the PCB Program

— Conclusion

- Appendix C supports Section III with a detailed listing of specific action items that are recommended to the PCB Program partners implement the PCB Program Strategy.

SECTION III — PCB PROGRAM STRATEGY

The mission of the PCB Program is to assist existing and future transportation professionals, working in the public and private sectors, to develop the knowledge, skills, and abilities to plan, design, install, operate, manage, maintain and evaluate ITS more efficiently and effectively. Towards this end, the PCB Program will continue to provide training and education that is *tailored* in its content, *targeted* to meet audience needs, and *accessible* where, when, and as needed. Given the findings and analysis of the needs assessment, this section presents six strategies for moving the PCB Program toward its goals.

THE PCB PROGRAM STRATEGY

The six strategies of a comprehensive PCB Program are:

- 1) Develop new curricula and courses
- 2) Deliver new courses
- 3) Create a virtual and continuous learning environment
- 4) Expand and strengthen the PCB partnerships
- 5) Expand PCB communications and outreach
- 6) Continuously improve the PCB Program

The success of each strategy relies upon the willingness of the PCB Program partners to undertake actions that best correlate with their strengths and expertise. Each strategy includes a series of priority actions and mainstreaming actions:

- Specific priority actions correlate to pressing ITS training and education needs that need to be addressed in the near-term (present – FY 2000)
- Mainstreaming actions ensure that other organizations are including ITS training and education into their programs. These items will be addressed in the longer-term (FY 2001-2002).

Appendix C presents a timeline of detailed actions. The timeline lists those actions completed during 1996-1998. It includes the actions that are underway in 1999. And, it lists the specific actions included in the FY 2000 budget and those proposed for FY 2001-2002. A critical measure of success for the PCB Program is the mainstreaming of these activities within the conventional training and education programs of the U.S. DOT and PCB Program partners. At the end of FY 2002, it is envisioned that the ITS PCB training and education, as currently defined, will be completely mainstreamed; and that the U.S. DOT PCB Program will be “sunset,” having achieved its goals.

1) DEVELOP NEW CURRICULA AND COURSES

The mission of the ITS PCB program is to provide ITS training and education for transportation professionals. Training and education depend upon having the appropriate and relevant courses available that enable professionals to build essential competencies. This includes enhancing existing transportation courses to include ITS content as well as developing new courses directly related to the ITS challenge. In addition, professionals seek guidance a path of learning, what courses to take, what level of proficiency, and what sequence of study.

Developing ITS training and education courses and ITS curricula, therefore, is the primary strategy of the PCB Program. There are three sub-components to this strategy:

- 1a) Develop model ITS curricula
- 1b) Enhance existing courses
- 1c) Develop new courses

The results of implementing this first strategy will be the following:

- There is a more clearly defined set of responsibilities for curriculum and course development by U.S. DOT, universities, professional associations, and the private sector.
- Training courses are developed and enhanced by FHWA business units and FTA program offices in conjunction with NHI, NTI, and NTC, and other PCB Program partners to meet needs. These courses can be tailored to provide job-relevant training to professionals.
- Universities establish extensive education programs and curricula, providing the basic education for new entrants to the public and private sector.
- Ongoing university initiatives establish new undergraduate and graduate level programs.
- Private sector establishes a curriculum and provides extensive, hands-on training; universities, colleges, junior and technical and vocational use the findings of the needs assessment to develop training and education programs.

1a.) Develop Model ITS Curricula

This component is focused on developing guidelines on ITS curricula for existing professionals in the public and private sectors, and creating model curricula for use within the academic community for developing future transportation professionals.

Priority Actions:

- Develop a draft set of curricula (provided in Appendix E of this report).
- Convene a series of workshops to review and critique curricula by the PCB Program partners (scheduled for Spring and Summer 1999).
- Once finalized, modify and distribute the ITS curricula among transportation professionals to use as guides for developing individualized ITS training and education plans.

- Distribute among PCB Program partners to be used as the basis for developing ITS training and education programs.

Mainstreaming Actions:

Once the ITS curricula are validated, the PCB Program will publish the curricula on the PCB Program web site. Further distribution will rely upon the PCB Program partners who will be invited to modify and distribute the curricula to their constituents and members. Successful mainstreaming can be measured by the following criteria:

- ITS curricula will be a basis for PCB Program partners' training and education programs (both in the public and the private sector).
- Comprehensive university model curricula for future professionals will be fully implemented.
- Curricula will address the needs of transportation professionals involved in metropolitan, rural and commercial vehicle ITS programs.
- The private sector will develop curricula and professional certification for their members (e.g., ITE's new traffic engineering certification).
- FHWA and FTA will use the curricula as guidance for agency career track development (e.g., FHWA's recent Resource Center reorganization and staffing).
- State DOTs and local transportation agencies will use the curricula to help determine typical ITS staffing requirements and competencies.

1b) Course Enhancements

Existing courses can be enhanced to:

- Continually update materials to reflect new developments.
- Tailor and target training and education programs to increase relevancy to audiences.
- Diversify the delivery methods to include technical assistance programs, continuing education initiatives, long distance learning, and information outreach and dissemination programs.

Priority Actions:

- *Enhancements and updates need to be made to existing training and education courses, which are on target, but can more fully satisfy the needs identified in this report.* One such initiative already underway through the U.S. DOT and NHI is the tailoring of the course, "Deploying Integrated Intelligent Transportation Systems." Modules are being incorporated to present either a focus on Metropolitan ITS or Rural ITS. Another example is the tailoring of an introductory course on the National ITS Architecture. FTA is addressing the more specific information needs of field staff by tailoring the "Introduction to the Architecture" course for this specific audience.
- *PCB partners should incorporate lessons learned, successful approaches, and best practices into existing training and education courses.* Appropriate case studies for problem-solving are already being incorporated. A set of case studies, referred to as

“sponge studies” that document successful approaches to ITS deployment, will be available from the ITS Joint Program Office beginning in Spring 1999. Each study will be incorporated as learning materials into the relevant PCB training courses.

Mainstreaming Actions:

PCB Program partners should take existing training and education and modify the courses to fit the needs of their members, or the needs of their local ITS deployments. The U.S. DOT will enhance existing training to encompass metropolitan, rural and commercial vehicle ITS applications. Once fully developed, the materials will be made available to PCB Program partners for further use, modification, and distribution. Successful mainstreaming can be measured by the following criteria:

- ITS PCB training courses will reflect up-to-date successful approaches and best practices.
- The ITS PCB Program will make the various training course modules available to PCB partners to structure new courses based on target audiences’ needs.
- The U.S. DOT PCB Program will play a limited role in further course development and enhancements.

1c) Course Development

Developing the ITS curricula also provides an opportunity to identify the “gaps” in ITS training and education as well as the “gaps” in providing accessibility through delivery. New development efforts will be needed to fill in these gaps, including the completion of high-priority courses currently under development by U.S. DOT and PCB partners.

Priority Actions:

- *New courses that address the top ten needs will be required.* Topics that build competencies in the top ten list include:
 - Principles of systems engineering;
 - Principles of telecommunications engineering;
 - Transportation basics and fundamentals;
 - ITS project management;
 - Bridging public-private sector differences;
 - Data analysis and management for ITS;
 - ITS standards training;
 - ITS planning tools.
- *The PCB Program and its partners must continue to develop and deliver new courses that contain the most job relevant content and that address the top ten competencies.* Courses currently under development are:
 - An Introduction to the National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards (now available; see the catalog for scheduling at: <http://www.its.dot.gov/pcb/98catalg.htm>)

- The National ITS Architecture: An introduction for FTA Senior (now available; see the catalog for scheduling at: <http://www.its.dot.gov/pcb/98catalg.htm>)
 - ITS Software Acquisition (now available; see the catalog for scheduling at: <http://www.its.dot.gov/pcb/98catalg.htm>)
 - Lessons Learned in ITS Procurement
 - Use of the CORSIM Computer Traffic Simulation Model
 - Procuring and Managing Systems Integrators (ITS America)
 - Sensors, Data Exchange and Interoperability (ITS America)
- *The PCB Program and its partners will pilot a series of long distance learning initiatives to evaluate their effectiveness.* The following initiatives are under development (more detail is provided in Appendix C):
 - Three interactive CD-ROMs
 - Video Conferencing / Satellite Transmission of ITS training
 - Web-based Training
 - Evaluation of long-distance Learning media for the ITS PCB Program through pilot initiatives.

Mainstreaming Actions:

The U.S. DOT PCB Program will take a more targeted role in course and media development over time, expecting that the groundswell of activities by PCB Program partners will adequately fill the gaps. In order to ensure that the priority gaps are filled, the U.S. DOT PCB Program will provide seed funding for interesting course development efforts that address the priority areas. Successful mainstreaming can be measured by the following criteria:

- The U.S. DOT PCB Program will ensure that existing training and education encompasses all of the ITS competencies, with the top ten needs receiving highest priority in that development.
- Existing PCB training and education will be available on the PCB web site with links to more detailed and informative sites.
- Partner organizations will offer ITS training and education through long-distance media.

2) DELIVER NEW COURSES

Delivery of ITS training and education is the second strategy of the PCB Program. Delivery can take many forms. At this point in time, the predominant form of ITS PCB delivery is the traditional classroom style. While it is appropriate for some courses, such as the three-day, hands-on *Using the National ITS Architecture for Deployment* course, other forms of delivery media are needed. The PCB Program must incorporate the use of advanced teaching technologies in the design and delivery of training and education programs, as well as develop instructors skilled in teaching with these technologies.

Additionally, in the future, courses developed for classroom delivery must be based on the principles of Instructional Systems Design (ISD), which provides instruction that is appropriate to meet modern adult education requirements. This includes the training and certification of qualified instructors. Together, the combined use of advanced teaching technologies and skilled instructors can overcome many of the barriers to building professional capacity building.

An important question is which organizations should deliver ITS training and education in the future. As ITS training and education is distributed to the many partners for modification and increasingly sophisticated refinements at the local level, the existing courses remain an important introduction to ITS for new entrants to the field. Thus, the existing U.S. DOT PCB Program courses will be transitioned to its FHWA and FTA partners for continued delivery as the U.S. DOT PCB Program begins to limit its role.

The results of implementing this strategy are the following:

- Fully developed distance learning is in place by the year 2002 as part of U.S. DOT learning initiatives in conjunction with partners.
- FHWA Resource Centers have fully-trained staffs to offer training and technical assistance; Division Office personnel approaching same capability. FTA Regional Offices have trained staff to offer training and technical assistance, and are able to utilize the resources of the FHWA Resource Centers.
- By incorporating courses and scheduling into partner organizations, and by widening the choices for distance learning delivery, delivery of tailored courses can be targeted to meet audiences' needs.

Priority Actions:

- *Continue to deliver existing courses.* Work with partners NHI and NTI to transition the scheduling and delivery activities into their established training program.
- *Improve classroom delivery* by working with NHI and NTI to update existing courses and modify them according to ISD principles.
- *Train and certify instructors* in field and at U.S. DOT headquarters. Create an awareness of how to utilize and teach with advanced teaching technologies such as satellite broadcast equipment.

Mainstreaming Actions:

The U.S. DOT PCB Program will move the scheduling and delivery of developed courses into partners' training programs, especially NHI, NTI and NTC. U.S. DOT will oversee the regular update and posting of the PCB catalogs of courses, university courses, and private vendor courses to the web. It is expected that other PCB Program partners will continue to contribute to the catalog postings and make their ITS training and education available to transportation professionals. Successful mainstreaming can be measured by the following criteria:

- Course offerings and scheduling will be incorporated into partner organizations.
- Partner organizations' catalogs will market the ITS courses and the U.S. DOT's PCB Course catalog will be phased out.

3) CREATE A VIRTUAL AND CONTINUOUS LEARNING ENVIRONMENT

Interviewees related that many barriers constrain their attendance at training and education courses. New delivery methods are desired that deliver more accessible and convenient training and education. They desire learning “anywhere, at any time”, and materials at varying levels in order to continuously build knowledge and skills. The same communications, information, and computer technologies that underlie ITS are also the cornerstone of an “information infrastructure.” This infrastructure can provide a virtual and continuous learning environment.

EXHIBIT III-1: WHAT IS A PCB VIRTUAL LEARNING ENVIRONMENT?

What is a PCB Virtual Learning Environment?

A virtual learning environment consists of providing a mix of the following components to promote accessibility to ITS training and education:

- A proactively managed Internet web site with interactive PCB courses, a feedback mechanism for questions, FAQ modules, links to more detailed sites.
- Satellite broadcasts of scheduled PCB courses from the U.S. DOT, NHI and NTI, and universities.
- CD-ROMs of PCB courses.
- Videotapes and video broadcast over the internet of PCB courses from the U.S. DOT and universities.

Benefits for the PCB Program include:

- Provides consistent information across a wide audience.
- Provides continuous learning opportunities at a variety of levels.
- Measures demand and track frequently asked questions.
- Quickly responds to new needs and updates materials in a timely fashion.
- Keeps delivery costs low – administration of program and students is efficient and cost effective.
- Uses staff more efficiently – no need to have instructor/presenters traveling constantly.
- Provides access to a wider audience – geographical and time barriers are overcome.
- Increases participation – much easier to manage large student load.

Benefits for the student include:

- Self-paced learning.
- Convenience – courses can be taken at any time, day or night, weekends, etc.
- Overcomes constraints of funding, time, and travel and geography – expenses are typically low, there is less “down time” as there is less need to be away from the job, and courses can be taken anywhere at any time.
- Course availability – many courses can be offered at the same time.
- Up-to-date information – course content is easily updated.
- Peer & expert interaction – discussion groups and ease of communication through email.

The primary result of implementing the third component is accessible professional capacity building.

Priority Actions:

- *Develop the PCB web site.* The PCB web site will be a proactively managed site with a feedback mechanism for questions, a series of Frequently Asked Questions (FAQ) modules, and linkages to other sites. Linking all PCB resources also provides “one-stop shopping” for professionals.
- *Work with PCB partners to develop pilot state programs to reach target audiences with more opportunities.* The U.S. DOT PCB Program will provide seed funding to develop these pilot programs.
- *Develop and assess distance learning media to complement the web site activities.*

Mainstreaming Actions:

Once the PCB web site is developed, it will be transferred to a partner organization for upkeep and maintenance. Pilot state programs will work cooperatively with PCB partners to reach larger audiences. An assessment of distance learning media will allow PCB program partners to develop new training and education using other means besides traditional classroom learning. Successful mainstreaming will be evaluated by the following criteria:

- A group of “pilot states” and possibly regions (e.g., the I-95 Corridor Coalition) will implement ITS education and training tailored for individual state and local needs.
- The PCB Program will have established a network of PCB partners with the required distance learning infrastructure, making it possible to reach the widest audience of transportation professionals.
- This network will be linked through the ITS PCB web page, allowing transportation professionals to easily access training, education, technical assistance programs, and information as needed.
- Once fully established, the U.S. DOT PCB Program will transfer the management, upkeep and maintenance to partner organizations.

4) EXPAND AND STRENGTHEN PCB PARTNERSHIPS

Addressing longer-term actions for enhancing and improving the PCB Program will require more formal clarification of the roles and responsibilities of the PCB Program and its partners. As we look to the future of the PCB Program, it is essential that all partners be engaged and assume roles appropriate to their strengths and expertise. The recommendations for enhancing, expanding, and evolving the PCB Program require leveraging the capabilities and commitment of its partners. The PCB partners who are participants in implementing professional capacity building fall into three categories: public sector, academia, and the private sector.

These partners have and will continue to play a critical role in a wide variety of program activities such as:

- Developing, updating and/or tailoring ITS professional capacity building training and education programs using the ITS curricula;
- Delivering ITS courses to target audiences;
- Building awareness of ITS PCB within their memberships through outreach and communications;
- Helping their members gain access to PCB information and materials;
- Using this report's framework of roles, competencies and delivery methods, more fully assess the needs of their constituent members to help expand the audience scope of the PCB Program; and
- Ongoing monitoring of the demands and interests of their membership.

The results of implementing the fourth component are:

- A network of partners linked through technology, that allows transportation professionals to access the right level of job-relevant training “on-demand,” and expands the scope of available PCB resources.
- In-depth analyses of transportation professionals ITS training and education needs, provided by PCB partner organizations, that are specific to target audiences.

Priority Actions:

- *Further define the role of partners.* The preliminary roles are defined on page 5 of this report. Forums for further discussion will be held to assess how partners wish to be more fully involved.
- *Ask partners to continue to assess the needs of their members* using the needs assessment framework provided by this report.
- *Leverage distance learning infrastructure already in place.*
- *Seed fund partners for new PCB initiatives*
- *Coordinate with partners in new course development.* For example, there are two new courses currently under development with ITE and ITS America.
- *More fully involve the LTAP centers as a way to reach a larger audience of transportation professionals.*

Mainstreaming Actions:

The U.S. DOT PCB Program will provide seed funding to partners for new PCB initiatives. The U.S. DOT PCB program will work to establish a network of cooperative relationships to leverage existing distance learning infrastructure. The U.S. DOT PCB Program will provide partners with its training materials to incorporate into their existing training and education programs.

Successful mainstreaming can be measured by the following criteria:

- Universities, colleges, junior and technical and vocational use this and other needs assessments to develop training and education program to meet transportation needs and provide a source of students with an ITS understanding to the professional world.
- A network of professional capacity building organizations exists, with each partner participating based on its unique strengths and expertise.
- Partner organizations will continue to conduct more targeted needs assessments of their constituent members.

5) INCREASE PCB PROGRAM COMMUNICATIONS AND OUTREACH

There is a greater need to better communicate the availability of the ITS PCB program training and education resources and to reach a wider audience of transportation professionals. The needs assessment revealed that:

- *Greater effort must be placed on making professionals aware of the vast amount of information available.* An additional problem at the opposite end of the spectrum is the information overload of reports, brochures, and the like that are not targeted to meet job relevant needs.
- *More tailored executive summaries on topics are needed.* Field staff desire tailored executive summaries and short presentations targeted to their needs, and electronic versions of reports that are searchable by key words. They also desire to have information available on a variety of media such as a centralized clearinghouse, an electronic library, and a web site.

The result of implementing the fifth component is that widespread knowledge about the ITS PCB program and its resources will have been generated throughout the transportation industry.

Priority Actions:

- Provide outreach and communications about the types of skills needed for ITS applications and the types of resources available to increase proficiency.
- Market the availability of PCB materials for training, presentations and marketing.
- Update three catalogs for the U.S. DOT PCB courses, university courses, and private sector courses.

Mainstreaming Actions:

- Place the PCB materials on the PCB web site for use by partners in outreach, communications and marketing.
- Provide regular updates on PCB information to the National Associations Working Group for the ICDN newsletter, ITS America for the Access ITS web site, and to other associations such as ITE or APTA.
- Place the catalogs on the web site for ease of access and updating. Encourage a partner organization to eventually take over the management, upkeep, and maintenance of the PCB web site.

Successful mainstreaming will be evaluated by the following criteria:

- All new information on ITS PCB will be transmitted electronically through established partners' electronic infrastructure, such as the ICDN.
- Professional associations will help communicate the opportunities available to transportation professionals for ITS PCB, creating a more targeted access to specific audiences.

6) CONTINUOUSLY IMPROVE THE PCB PROGRAM

The PCB has continuously evolved as the ITS technology and program have developed, and as the number of partners expands and the activities are mainstreamed. The ultimate goal is to phase out the currently defined program, once having reach a wide audience of transportation professionals involved in ITS, with clear indications of success.

To generate a sense of how well the program is responding to ITS training and education needs, activities to evaluate the program will need to be instituted.

The results of implementing this sixth strategy include:

- Eventual “sunset” of the ITS PCB Program, as currently defined, with the knowledge that the partners have created a successful ITS PCB Program and mainstreamed the components into their own training and education programs.
- ITS training and education programs have become an integral part of Operations, Management and Maintenance training and education activities.

Priority Actions:

- Evaluate the program through a PCB web-site evaluation mechanism that notes whether web-based training meets needs in a tailored, targeted and accessible way.
- Collect student feedback from courses to evaluate whether the training was appropriately tailored, targeted and job-relevant.
- Note whether the transportation industry is finding qualified future professionals. This might include a case study with PCB partners to evaluate whether the change in university and other academic curricula is providing knowledge and skills related to ITS and operations and management.
- Expand PCB training to meet needs of other audiences such as commercial vehicle transportation professionals. This involves the tailoring of training course modules and associated lessons learned, best practices, and successful approaches to the audience.
- Be ready to address the needs of the Rural ITS Program and the Intelligent Vehicle Initiative as they emerge. Other future expansion may also include the air system (airports) and surface inter-modal systems.

Mainstreaming Actions:

It is envisioned that U.S. DOT and other PCB partners — professional associations, State and local governments, and universities — will take on the responsibility of training and educating current and future generations of transportation professionals in ITS as part of their ongoing training and education programs. The above measures of evaluation can be used to determine whether these goals are being met by the year 2002, when the PCB Program phases out.

CONCLUSION

The world is changing at an increasingly rapid rate, driven in part by advances in technology. By utilizing technology, transportation agencies will be challenged to create a continuous learning environment that can adapt and leverage technologies as they change and improve to meet the needs of their customers. Building this professional capacity will require an environment and infrastructure that can facilitate learning, not only through technology, but most importantly through a tightly woven network of individuals and institutions that can link transportation professionals to resources and to each other on an as needed and just-in-time fashion.

The result of implementing this PCB Program strategy is that individuals and institutions, working at all levels — local, State, regional, and national — will be able to realize and have the competencies to ensure that ITS realizes its full potential to create more efficient, safe, and effective surface transportation systems.

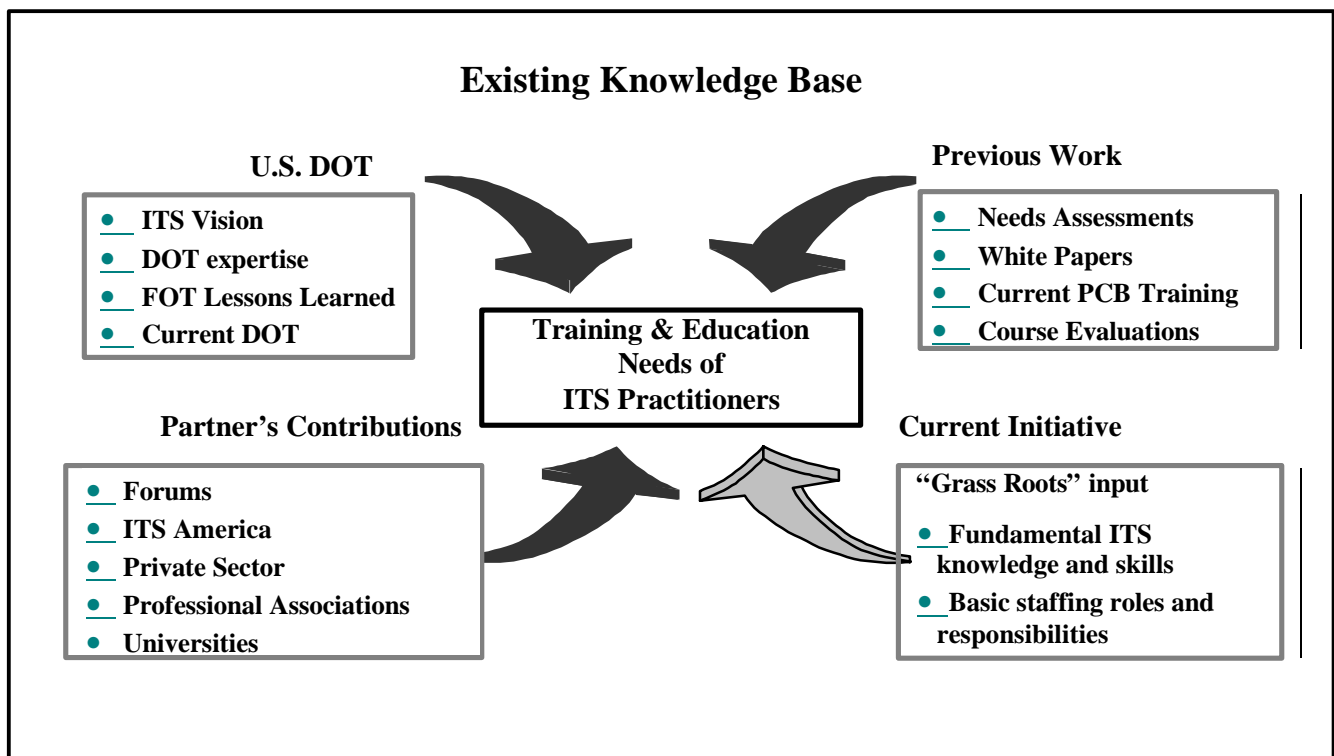
APPENDIX A: RESEARCH METHODOLOGY

A.1 The Research Methodology

The challenge in developing the research methodology was to understand how to add *depth and breadth* to the existing knowledge base. It required that the effort:

- include a wider than previous audience of professionals across ITS projects, agencies/firms, job levels, and deployment stages; and
- gather more in-depth details about their roles and the supporting knowledge and skills.

The methodology developed involved many components for collecting and analyzing information. The first component was a literature review of the large body of work previously undertaken to better understand ITS professional capacity building, as well as of the resources that had been developed in response to known needs¹.



¹ A listing of the literature sources is provided in the Bibliography, Appendix B.

Second, a series of discussions was held with experts in training and education.¹ These discussions formed the foundation for generating an interview guide that was focused more specifically to two key professional and technical audiences:

- public sector agency staff, and
- private sector firm contractors and consultants.

Third, an interview guide was designed to elicit the following information:

- 1) The **role of the agency or firm** in ITS deployment and ongoing operation. This information reveals the more specific staffing and competency needs of both projects and agencies.
- 2) The **role of the interviewee** on the project, including his/her experience, qualifications, and educational background. This information was needed to develop a range of ideal ITS roles.
- 3) The **fundamental knowledge and skills** required for the role, given the type of deployment. This information formed the basis of the range of ITS competencies.
- 4) The **“ideal” staff roles and background**, if the project could be staffed without concern for finances, to identify the needs and shortages in expertise and staffing

A survey was included as part of the interview guide. Interviewees were asked to review a list of thirty-nine “ITS knowledge areas” that were developed through a comprehensive literature review and expert panel before the interviews started. The survey was intended as a means of generating more detailed discussion on fundamental knowledge and skills areas. It also provided interviewees with an opportunity to rank their priorities. Lastly, the interviews were conducted.

A.2 Scope of the Interviews

The following criteria were used to define the scope of the interviews:

- ITS program areas and the types of ITS projects;
- Geography and varying levels of deployment progress;
- Diversity of agencies;
- Categories of professionals.

ITS Program Areas and Types of ITS Projects

The study targeted deployments of Metropolitan ITS Infrastructure as these sites tend to be the furthest along and incorporate many of the same PCB needs required by rural or commercial vehicle operations. Importantly, this work establishes a framework that can easily be adapted to studying the needs of professionals in the other program areas.

The Metropolitan ITS Infrastructure program is comprised of nine elements, or types of systems that provide services. Eventually, the interviews covered six out of nine elements:

¹ Expertise was provided by staff at the National Highway Institute, FHWA’s Office of Personnel and Training, the National Transit Institute, FTA, independent consultants, and university research faculty in ITS.

<u>Metropolitan Element</u>	<u>Covered in Interviews?</u>	
	<i>Yes</i>	<i>No</i>
Incident Management Systems	R	
Freeway Management Systems	R	
Emergency Management Systems	R	
Advanced Public Transportation Systems	R	
Advanced Traveler Information Systems	R	
Electronic Toll Collection Systems		R
Electronic Fare Payment Systems		R
Traffic Signal Control Systems	R	
Highway-Rail Crossings		R

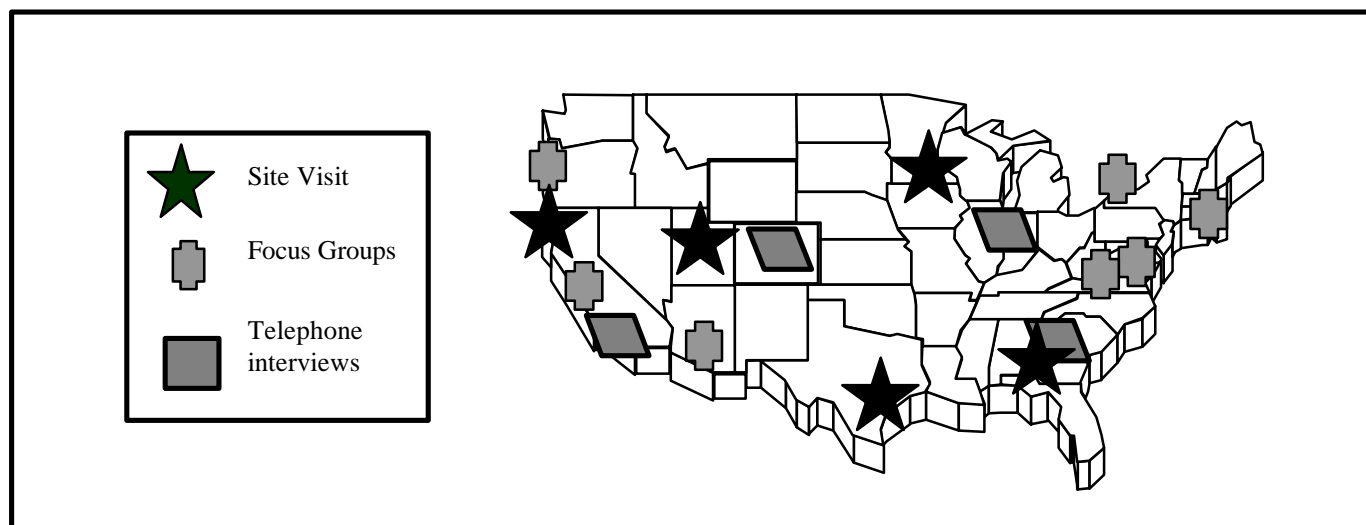
The Highway-Rail Crossings metropolitan element was not covered due to the lack of projects in this area. The Electronic Toll Collection and Electronic Fare Payment elements, while well-developed areas nationally, were not well enough represented in the interviews to provide an evaluation.

In addition, a number of deployments that cut across the Metropolitan elements were examined:

- Transportation Management Centers (TMCs);
- Smart Corridors;
- Road/Weather Information Systems (R/WIS).

Geographic Scope and Varying Levels of Deployment Progress

The geographic scope of this effort was designed to be national, through the use of site visits, focus groups, and telephone interviews. Previous studies indicated how experience and perspective can vary based on geography of the deployment. The following map illustrates the extent of coverage:



The criteria used for selecting sites was a combination of:

- **Levels of site deployment.** Five sites were eventually chosen to include a range of high, medium, and low deployment progress. A site profile is included below on page A-6.
- **Experience and perspective of agencies and practitioners.** Each site plan included a mix of various transportation agencies and firms. In addition, two focus groups were arranged — one on transit and one on traffic operations. Experienced public and private practitioners were invited to participate.
- **Invitations by practitioners.** The needs assessment effort took advantage of generous offers of participation made by PCB Steering Committee members that included their respective staffs.

Diversity of Agencies

The interviews revealed that the roles agencies played within a region, and among regions, varied according to the size of the agency, its operating budget and funding limitations, and its mission. Like agencies in different regions often faced very different political climates and organizational arrangements. Nonetheless, in order to simplify comparisons, the following categories were used to classify organizations:

- State DOTs (SDOTs)
- Transit Agencies, both multi-modal, and bus only
- Metropolitan Planning Organizations (MPOs)
- City/County DOTs, also known as Departments of Public Works
- Transportation Management Centers (TMCs), also known as Transportation Operations Centers (TOCs)
- Federal Field Staff at FTA Regional Offices
- Federal Field Staff at FHWA Regional and Division Offices.¹

Categories of Professionals

In order to capture the wide variety of needs across a diverse audience, approximately 200 individuals were interviewed either one-on-one or during focus group sessions. These individuals held a variety of positions in public agencies, private firms and universities including, but not limited to:

- Senior executives and program managers
- Project managers
- Consultants
- Analysts
- Operators
- Field technicians and maintenance staff
- Professors.

¹ Note: Regional Offices were still operational during the interview effort. They have since ceased operation and four Resource Centers have been established. The Resource Centers will have staff dedicated to ITS and will include the ITS Specialist position that was in effect during the interviews. From this point, the report will refer to the Resource Centers.

The interviews also included professionals who were not specifically associated with an ITS deployment or operations project, but were part of a more regional effort that required inter-agency cooperation.

Sample Size

The interview process attempted to capture the current mix of individual backgrounds with their corresponding levels of experience and responsibility. It was not meant to be a scientific sample, but rather representative of the roles, knowledge, and skills required by a range of transportation professionals involved in ITS. While the information has been categorized according to agencies, audiences, and ITS projects, and used to prioritize needs, it is recognized that some categories of interviewees do not have adequate sample sizes to present “scientific” results.

A.3 Assumptions

The following assumptions were used to generate the interview guide(s):

- 1.) The process of deployment for transportation projects can be divided into seven somewhat discrete stages: Planning, Design, Procurement, Installation, Operations, Maintenance, and Evaluation.

Deployment Stages:



- 2.) Identifying the deployment stages helps to recognize the following:
 - When cross-agency interaction and cooperation happens or needs to happen
 - The individual roles that make it happen, and when they are needed
 - The competencies that support those individual roles.
- 3.) An understanding of more than just content is necessary. Also required is the understanding of *who* has the needs (roles) and *how* those individuals most effectively receive professional capacity (delivery methods). These three categories of needs — content, roles, and delivery — form the basic “building blocks” that shape a relevant professional capacity building program.

Limitations

- a.) This study specifically addresses professional capacity building for Metropolitan ITS infrastructure deployment and operations. Future efforts will need to address transportation professions involved in the deployment and operations of CVISN, Rural ITS infrastructure, IVI and other areas as they emerge.

- b.) This study focused on practitioners “from the field” who work day-to-day in support of ITS deployment, operations, and maintenance. Future efforts will need to address those professionals who work within U.S. DOT headquarters to provide policy and set direction for the ITS Program.

Regarding the survey that was used as part of the interview process, there were a number of suggestions for items to be “added” to the list of thirty-nine knowledge areas. Most of these suggestions were project or agency specific. The survey, however, was not modified, so that it would remain consistent throughout all of the interviews.

APPENDIX A — SITE PROFILES

The goal in conducting the interviews was to talk to as many people as possible, at different kinds of agencies and at different levels within each organization. The team did not design a statistically “random” sample. With the limited time and budgetary constraints the assessment team worked with, the willingness and availability of the interviewees was a key factor to the success of the project. Every effort was made to minimize the impact of the interviews on the local agencies while at the same time making an effort to cover the broad spectrum of agencies with some depth.

Site Interview Profile

The majority of interviews were held with practitioners at their agency

INTERVIEW LOCATIONS	Level of Deployment	Interviews
Atlanta, Georgia Minneapolis-St. Paul, Minnesota Houston, Texas	High	69
San Francisco Bay Area, California	Medium	62
Salt Lake City, Utah	Low	25

Focus Group Profile

Three focus group meetings were held to bring together practitioners from different agencies or locations.

Agency Type	Location	Representing	Participants
Transit-Public and Private Agencies	Washington D.C.	<ul style="list-style-type: none">• Washington D.C• Maryland, Virginia• Private Sector, including experience in Salt Lake City and Texas	8
Highway-Public Agencies	Toronto, Canada (ITE Annual Meeting)	<ul style="list-style-type: none">• Phoenix, AZ• Portland, OR• Virginia DOT• Menlo Park, CA	5
Highway-Private Consultants	Toronto, Canada (ITE Annual Meeting)	Deployment projects across the Nation	3

Telephone Interviews Profile

In addition to site visits and focus groups, telephone interviews were held with a variety of practitioners:

Agency Type	Location	Representing	Participants
Private Sector Consultants	Maryland, New York City, Los Angeles, Cincinnati	<ul style="list-style-type: none"> Private Sector, including experience in Atlanta, Maryland, Salt Lake City, and other sites 	4
Highway-Public Agencies	Salt Lake City Denver, CO Los Angeles Santa Clara Valley, CA	<ul style="list-style-type: none"> Salt Lake City Southern California Santa Clara Valley, CA 	6
University	Utah	<ul style="list-style-type: none"> Salt Lake City 	1

Altogether, 183 interviews were formally conducted with practitioners engaged in deployment and operations activities.

Diversity of Agencies

The survey team recognized that the actual role transportation agencies play within a region, and among regions, varies according to the size of the agency, operating budget, funding limitations, and mission. Similar agencies in different regions of the country often face very different problems due to geography, weather, political climate, source of funding and organizational structure. An effort was made to obtain interviews across various sized agencies of the following types.

Agency Type	# of Interviews
State DOTs	55
Transit Agencies, both multi-modal, and bus only	46
Metropolitan Planning Organizations (MPOs)	20
City/County DOTs, also Departments of Public Works	13
Transportation Management Centers	17
FTA Regional Offices	5
FHWA Resource Centers and Division Offices	9
Private Sector Firms	14
Universities	4

Specific breakdowns are not available by role because of the wide variety of position descriptions and the fact that many of the interviewees did not fit cleanly into one category or another (many had two or more roles). Also, in many cases multiple individuals participated in the same interview, while in others the interviews were “one on one.”

APPENDIX A — INTERVIEW GUIDES

Introduction to both Public Sector and Private Sector Guides

I. Introduction (5 minutes)

Who we are

Let us introduce ourselves. We are staff from the Volpe National Transportation System Center, in Cambridge, MA. The **Volpe Center** is the research and special projects arm of the DOT.

We are conducting a project for the **Joint Program Office** that addresses the unique training and education needs of Intelligent Transportation Systems (ITS) deployment. ITS is the research, development, testing, and deployment nationwide of information technologies and computer systems, and the integration of those systems to more efficiently manage surface transportation.

Why we are here

Our interest in talking to you today is to learn **what skills, knowledge and staffing** you needed to be successful in the planning and deployment of your ITS project.

US DOT has already established a comprehensive set of training seminars and short courses covering the ITS program. However, there is a clear need to acquire more detailed information, leading to the implementation of more comprehensive training and education initiatives in the areas you see as the greatest priorities. We want **to use your experience and expertise to assist other transportation professionals** in meeting the challenges you have met, as well as understanding what you may need in the future.

Handout: Specifically, we want to address

- fundamental knowledge and skill areas required for ITS deployment
- new and evolving agency and private sector roles and responsibilities
- staffing issues that need to be considered at all levels and for all activities
- prioritization areas for education and training
- changes in inter-agency and intra-agency, and private/public sector relationships that are generated by changes in transportation technology and the resulting shift in focus to operations and management
- present and future learning initiatives and most appropriate delivery methods

Why you are here

To **help us understand** outcomes as applied to your project(s), specifically, knowledge base and skills required for this project

The newness of advanced technology applications that are now available has required you and other members of your (in-house or contracted) staff to **develop or acquire new expertise**. We want to understand the following:

- what **expertise you possessed prior** to becoming involved in advanced technology-related projects;
- **what you have had to learn** since becoming involved;
- what are the **fundamental knowledge and skills** required for successful ITS deployments;
- **how you think resources should be allocated** in training and education for ITS.

What's in it for you

- Help other agencies based on your hands-on experience
- Help to allocate training and education resources by US DOT and others
- Help you and your organization understand your future ITS workforce requirements

II. Time: The interview will last 1 – 1.5 hours.

III. What we'll do with the data

Ground Rules:

- All information is confidential.
- The final results will be merged together, and no one agency/company will be identified.
- No other staff at the agency/company gets access
- If a tape is used, it will eventually be destroyed.

Products:

The products to be developed and made widely available to organizations include:

- Typical staffing requirements for “typical ITS projects”
- Knowledge, Skills, and Competencies required for different people
- A Training and Education Curriculum for ITS
- Recommendations on training and education roles and responsibilities

As we start, the interview will be very specific to capture as much detail as possible. Again, the emphasis is on what is unique to ITS deployments.

Interview Guide – Public Sector

1. Staff Roles & Responsibilities (20 minutes) (Specific Project(s)?)

A. Confirm type of agency — mission / function.

B. ITS elements / technologies (List):_____.

Planned

Designed

Procured

Installed

Operated

Maintained

Circle experience/state of project

Position Who are the people on staff with this project?	Roles and Responsibilities What do they do?	Background/Skills Why selected?	Staff or Contractor Why?

What roles on this project are missing? Why?

2. Knowledge and Skills (30 minutes)

Handout checklist: What are the most critical knowledge areas/skill areas this project needs to be successful? Check off most critical in the first column. (Write anything that is missing.)

- Now circle the top 5 and rank them in column 2.
- Discuss the top 3 selections in order...
- What level of knowledge was needed?
- Ideally with who is it most appropriate to house this responsibility?
- Who has it now?
- Within the agency who else needs to know about this? At what level?
- Outside of the agency?

Knowledge Areas for ITS Projects (Greatest Needs – Specific Project(s))

		A	B	C
Tran. Planning Process	1. Regional Concept Of Operations			
	2. Identifying Organizational Barriers and Managing Change			
	3. Coalition Building with New Stakeholders			
	4. Comparing/Combining ITS and Capital Improvements			
	5. ITS projects in the MPO Regional Trans. Plan/TIP			
	6. Developing a Business Plan			
	7. Data Sharing between Agencies			
	8. Risk Management			
	9. Partnerships – Structuring Public/Private Agreements			
	10. Public Relations			
Project Planning/Design	11. Technology Analysis — Range of Options			
	12. Cost/Benefit Analysis			
	13. Analysis of Existing ITS Infrastructure			
	14. Using the National ITS Architecture for Planning			
Procurement / Funding	15. Sources of Funding — Fed/State/Local/Private			
	16. Writing Specifications—Technical and Legal Issues			
	17. Procurement Options: Design / Build/Lease Agreements, Shared Resources Agreements and RFPs			
Contracts Management	18. Managing Software Development and Costs			
	19. Managing Contractors: Developers and System Integrators			
Systems Engineering	20. System Analysis and Design			
	21. Consistency with National ITS Architecture and Standards			
	22. Requirements Management			
	23. System Integration			
	24. Quality Assurance			
Telecommunications	25. Capacity Analysis — Transmission: Wireline v. Wireless			
	26. Lease / Build Decision Making			
Installation/ Deployment	27. Acceptance Testing			
	28. Use of Prototypes			
	29. Training			
Operations Center	30. Operations Center Staffing Requirements			
	31. Management of an Operations Center			
	32. Human Factors			
Legal Issues	33. Privacy of Data and Identification			
	34. Liability Issues			
	35. Security Systems & Network Vulnerability			
	36. Intellectual Property Rights			
Maintenance	37. Software/Data Maintenance			
	38. Inspection Procedures for ITS equipment / systems			
PROJECT EVALUATION	39. Project Evaluation			

Column A = For checkmarks indicating knowledge areas critical to interviewee's position.

Column B = For ranking the top five knowledge areas 1-5.

Column C = For checkmarks indicating knowledge areas critical to ITS in general, from interviewee's perspective.

3. Other Agencies

- A. What skill areas should other agencies provide?
- B. What kind of role do you expect FHWA / FTA to play in deployment?
- C. What kind of assistance do you currently receive from FHWA / FTA?
- D. What do you need to know about ITS standards? Why?

4. Needs (20 minutes)

- A. This activity is being conducted to provide guidance to allocate resources for training, education, and technical assistance. What are, and what do you anticipate to be, your most critical needs, that we might be able to address?
- B. How is that assistance best delivered?
 - Through Training
 - Manuals/guidelines
 - Scanning tours
 - On-the-job training/Peer-to-Peer network
 - professional associations
- C. What are the barriers to delivering this assistance?
- D. Who best delivers this type of support?
 - Internal staff
 - Federal agencies
 - Universities
 - Commercial Vendors

5. Ideal--Given no funding constraints (10 minutes)

- E. If you were called in to set up a staff for a similar project, what would the ideal team with the desired knowledge and skills look like?
 - By position
 - By background
 - Specialist/Generalist
- B. Would it be in-house or contracted out?

Private Sector Interview Guide

1. Staff Roles & Responsibilities (20 minutes) (Specific Project(s)?)

- A. What type of ITS does your agency focus on, if any area is specific?
- B. On which types of ITS projects have you worked with the public sector? (ITS technologies, elements)

Position Who are the people on staff with these projects?	Roles and Responsibilities What do they do?	Background/Skills Why selected?

2. Private Public Sector Issues

- A. What has been the role of the private sector on these projects?
- B. What are the detailed technical and non-technical skills of your agency that makes projects successful?
- C. What is the role of the public sector agencies in ITS deployment? What are their core competencies that support their role?
- D. What kind of knowledge/skills do you expect from the public sector? Who should have these knowledge/skills in the public sector? Which should be required?
- E. What have the challenges been in working with the public sector in terms of a lack of skills/knowledge/staffing issues?
- F. What skills/knowledge do you think the public sector hires you for?
- G. How does your company stay on the cutting-edge of technology/knowledge?
- H. What Knowledge and Skills do you seek in hiring new entrants (BS, MS, PhD levels) to your firm?

Knowledge Areas for ITS Projects (Greatest Needs – Project Specific)

		A	B	C
Tran. Planning Process	1. Regional Concept Of Operations			
	2. Identifying Organizational Barriers and Managing Change			
	3. Coalition Building with New Stakeholders			
	4. Comparing/Combining ITS and Capital Improvements			
	5. ITS projects in the MPO Regional Trans. Plan/TIP			
	6. Developing a Business Plan			
	7. Data Sharing between Agencies			
	8. Risk Management			
	9. Partnerships – Structuring Public/Private Agreements			
	10. Public Relations			
Project Planning/Design	11. Technology Analysis — Range of Options			
	12. Cost/Benefit Analysis			
	13. Analysis of Existing ITS Infrastructure			
	14. Using the National ITS Architecture for Planning			
Procurement / Funding	15. Sources of Funding — Fed/State/Local/Private			
	16. Writing Specifications—Technical and Legal Issues			
	17. Procurement Options: Design / Build/Lease Agreements, Shared Resources Agreements and RFPs			
Contracts Management	18. Managing Software Development and Costs			
	19. Managing Contractors: Developers and System Integrators			
Systems Engineering	20. System Analysis and Design			
	21. Consistency with National ITS Architecture and Standards			
	22. Requirements Management			
	23. System Integration			
	24. Quality Assurance			
Telecommunications	25. Capacity Analysis — Transmission: Wireline v. Wireless			
	26. Lease / Build Decision Making			
Installation/ Deployment	27. Acceptance Testing			
	28. Use of Prototypes			
	29. Training			
Operations Center	30. Operations Center Staffing Requirements			
	31. Management of an Operations Center			
	32. Human Factors			
Legal Issues	33. Privacy of Data and Identification			
	34. Liability Issues			
	35. Security Systems & Network Vulnerability			
	36. Intellectual Property Rights			
Maintenance	37. Software/Data Maintenance			
	38. Inspection Procedures for ITS equipment / systems			
Project Evaluation	39. Project Evaluation			

Column A = For checkmarks indicating knowledge areas critical to interviewee's position.

Column B = For ranking the top five knowledge areas 1-5.

Column C = For checkmarks indicating knowledge areas critical to ITS in general, from interviewee's perspective.

3. Needs (20 minutes) – (use as appropriate)

- A. This activity is being conducted to provide guidance to allocate resources for training, education, and technical assistance. What are, and what do you anticipate to be, the most critical ITS needs, that US DOT might be able to address?
- B. How is that assistance best delivered?
- Through Basic Education
 - **Through Training**
 - **Manuals/guidelines**
 - **Scanning tours**
 - **On-the-job training/Peer-to-Peer network**
 - **Professional associations**
 - Other
- C. What are the barriers to delivering this assistance?
- D. Who best delivers this type of support?
- Internal staff
 - US DOT agencies
 - Universities
 - Commercial Vendors

4. Ideal—Given no funding constraints (10 minutes)

- A. If you were called in to set up a staff for a similar project, what would the ideal team with the desired knowledge and skills look like?
- By position
 - By background
 - Specialist/Generalist

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APPENDIX C: TIMELINE AND ACTION ITEMS TO SUPPORT THE PCB PROGRAM STRATEGY

1a) Curricula Development Action Items

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
<ul style="list-style-type: none"> Established a PCB curricula development plan based on a need to address three tracks of learning needs: Current Professionals (Track 1), Future Professionals (Track 2), and Elected & Appointed Officials (Track 3) 	<ul style="list-style-type: none"> Develop and distribute the first version of the “ITS Curricula” proposed in this report for consideration by PCB partners and transportation professionals (Summer 1999). Convene workshops with PCB partners to review the findings and highlight any issues regarding the curricula Provide input to professional associations such as ITE for curriculum development and professional certification Provide input to FHWA and FTA for agency career track development Work with university partners to develop model curricula for educational programs 	<ul style="list-style-type: none"> Finalize revisions to the ITS “curricula” and deliver them through PCB partners for public sector, private sector and academic use. Continue to work with universities to develop and implement model curricula. Work with PCB partners to expand the ITS curricula to include commercial vehicle and rural transportation professionals. 	<ul style="list-style-type: none"> ITS curricula are used as a basis for PCB Program partners’ training and education programs to address needs of current professionals (both public and private sector). Comprehensive university curricula fully implemented to address needs of future professionals. A comprehensive set of ITS curricula are in use, including commercial vehicle and rural, and clear educational linkages between urban, rural and commercial vehicle programs are established.

1b) Course Enhancements

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
(Courses were first under development based on known needs during this time period.)	<ul style="list-style-type: none"> • Current U.S. DOT PCB courses and seminars are undergoing review to update the course materials and incorporate the findings in this report. • Current courses are being tailored and enhanced to include TEA-21 initiatives and lessons learned from deployment. • Modify courses to reflect ISD learning principles. • Modify courses to utilize advanced teaching technologies and train instructors in their use. • Train and certify ITS PCB instructors at DOT headquarters and in the field. • Encourage PCB Program partners to review and revise their existing educational materials for similar incorporation of lessons learned, successful approaches, and TEA-21 initiatives. 	<ul style="list-style-type: none"> • Continue to update and tailor existing courses. • Modify existing courses to reflect ITS commercial vehicle and rural activities. 	<ul style="list-style-type: none"> • Training courses reflect up-to-date successful approaches and best practices and are tailored to specific audience needs, including commercial vehicle and rural. • U.S. DOT's PCB Program has transferred course enhancement activities to PCB partner organizations.

1c) Course Development

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
<ul style="list-style-type: none"> Developed a seven seminars and three two-to-three day short courses based on known needs of specific ITS topics. 	<ul style="list-style-type: none"> Continued to develop and deliver new courses that contain more job-relevant content and that address some of the top ten competency areas. The following are currently under development and will be available in FY 1999: <ul style="list-style-type: none"> ⇒ Introduction to the National Architecture and Guidance on Conformity. ⇒ Introduction to the National Architecture for FTA Senior Staff. ⇒ Use of the CORSIM Traffic Simulation Model. ⇒ ITS Software Acquisition. ⇒ Lessons Learned in ITS Procurement. Planning the development of new courses: <ul style="list-style-type: none"> ⇒ Turbo Architecture. ⇒ ITS Standards modules. Coordinating with ITE, ITSA in new course development to be available in FY 1999: <ul style="list-style-type: none"> ⇒ Managing Systems Integrators. ⇒ Advanced Sensors. Providing input on ITS competencies to FHWA and FTA for career track development, to private sector organizations to establish certification programs, and to public transportation agencies to aid in hiring and contracting. 	<ul style="list-style-type: none"> The PCB Program plans to provide “seed” funding to encourage the fulfillment of training and education “gaps” within the top ten competency areas. The proposed focus for new course development is on: <ul style="list-style-type: none"> ⇒ ITS and the principles of systems and telecommunications engineering; ⇒ Transportation fundamentals; ⇒ Project management for ITS; ⇒ Bridging public and private sector organizational/institutional differences; ⇒ ITS and data analysis and management; ⇒ ITS planning tools. Creation of new hands-on initiatives. In addition to training courses, workshops, labs and case studies are proposed to address needs related to the following topics: <ul style="list-style-type: none"> ⇒ <u>Managerial/Administrative Skills</u>: Problem-solving, managing contractors, negotiating skills, writing specifications, institutional issues. ⇒ <u>Technical Skills</u>: Equipment installation, maintenance, troubleshooting. Work with the commercial vehicle and rural ITS Program partners to identify their needs for future course development or course modifications. 	<ul style="list-style-type: none"> PCB Program partners are using the needs assessment report to identify “gaps” and develop new courses. Limited U.S. DOT involvement in new course development.

2) Course Delivery

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
<ul style="list-style-type: none"> Delivered available training activities to expanded audiences through U.S. DOT, national associations, State and local governments, and academia. Through FY 1998, over 5000 transportation professionals received some form of ITS PCB training. 	<ul style="list-style-type: none"> Transitioning the course scheduling function to the following PCB Program partners: <ul style="list-style-type: none"> ⇒ NHI ⇒ NTI ⇒ NTC Working on an assessment of distance learning media that includes piloting different forms to evaluate their technical feasibility and their success in reaching target audiences. Establishing the first set of “pilot” PCB programs in the field that will take existing PCB training materials and modify them to meet local needs. Also working to help “pilot” sites assess local needs. 	<ul style="list-style-type: none"> Planning to focus on training for FHWA Division and Resource Center, and FTA Regional Personnel to support the effort to move ITS leadership to the field. Continuing to train and certify DOT instructors at DOT headquarters and in the field. Planning to provide “seed” funding to encourage “pilot state” programs to establish themselves around the nation. 	<ul style="list-style-type: none"> A group of “pilot states” and possibly regions (such as I-95 Corridor Coalition) actively implementing ITS education and training, tailored for individual State and local needs. Course scheduling activities fully transitioned and ITS training courses scheduled and delivered by PCB Program partners, specifically, NHI, NTI, and OMC.

3) Creation of a Virtual and Continuous Learning Environment

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
<ul style="list-style-type: none"> Assessed the various forms of distance learning and other delivery media 	<ul style="list-style-type: none"> Working on an assessment of distance learning media that includes piloting different forms to evaluate their technical feasibility and their success in reaching target audiences. Beginning with the following course as a pilot: <ul style="list-style-type: none"> ⇒ The National ITS Architecture: An Introduction for FTA Senior Staff. Placing all existing courses and technical assistance programs on the ITS Program's web site. Developing a web page for the ITS PCB Program as the initial component of a "virtual learning environment" for transportation professionals. Working with PCB Program partners to initiate development of distance learning media for PCB delivery. Providing "seed funding" for a series of "pilot" initiatives that include: <ul style="list-style-type: none"> ⇒ Three interactive CD-ROMs for the following courses: <ul style="list-style-type: none"> - <i>ITS Awareness Seminar</i>. - <i>ITS Telecommunications Overview</i> (an SBIR initiative). - <i>Use of the CORSIM Model for Traffic Simulation</i>. ⇒ Video Conferencing / Satellite Transmission of ITS training: <ul style="list-style-type: none"> - <i>Public/Private Partnerships Seminar</i> to be broadcast via Tel-8 on May 4, 1999. ⇒ Web-based Training <ul style="list-style-type: none"> - I-95 Corridor/CITE Program has an introductory course on ITS underdevelopment by the University of Maryland - RPI is developing three courses for FHWA. - ITS America is in the process of researching the delivery of two new courses over the web. 	<ul style="list-style-type: none"> Plan to create Frequently Asked Questions (FAQs) modules for the proposed web site. Plan to implement distance learning delivery of existing courses in cooperation with PCB partners NHI, NTI, and OMC. Plan to develop a managed ITS PCB web page, including hyperlinks to more detailed sites. Plan to encourage PCB partners to link their PCB efforts to the ITS PCB web page. Plan to create a rolodex of deployment-related experts. 	<ul style="list-style-type: none"> Ensure the operations of a virtual learning environment to supplement traditional classroom activities with distance learning initiatives. This includes an operational ITS PCB web site that links PCB partners and PCB materials together for professionals to easily access. A regular series of publications are readily available in traditional written form on CD-ROM, on the world-wide web and all other media forms. Fully developed distance learning in place as part of U.S. DOT distance learning initiatives in conjunction with partners. The ITS PCB web site management is transferred to a PCB program partner. There is movement by U.S. DOT to become a continuous learning organization, incorporating the distance learning foundation established by the ITS PCB Program

4) Expand and Strengthen PCB Partnerships

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
<ul style="list-style-type: none"> First definition of PCB partner role provided through discussion at PCB Steering Committee meetings, ITS America's Training and Education Committee, and in the <i>PCB Framework and Overview</i> report (December 1997). First pool of instructors for ITS training established that included U.S. DOT, university, and consultant personnel. Began discussions with PCB program partners NHI and NTI on transitioning the PCB training, course development, and scheduling activities as an effort to mainstream ITS. 	<ul style="list-style-type: none"> Definition of PCB partner roles expanded and provided in this report. Further definition of roles to occur during a planned series of forums to discuss ITS curricula and future course developments. Instructor pool continues to expand with train-the-trainer and certification activities underway in FY 1999 in cooperation with NHI, FHWA and FTA. Establishing the first set of "pilot" PCB programs in the field that will take existing PCB training materials and modify them to meet local needs. Also working to help "pilot" sites assess local needs. Currently, two states (Florida and California) and one region (I-95 Corridor) are under development. University initiatives underway to establish new undergraduate and graduate level programs. NHI has accepted the majority of ITS PCB training and scheduling activities. 	<ul style="list-style-type: none"> ITS Education and Training in the early stages of becoming an integral part of Operations, Management and Maintenance, Education and Training activities. Expand pilot states; Utah and Virginia have plans for near-future development. More private-sector training to present hands-on learning. A catalog of existing private sector professional capacity building efforts is available on the ITS America web site. Plan to establish a network of university-based "ITS Institutes" for training middle management and technical professionals. Continue efforts to mainstream the ITS PCB Program into existing transportation programs by engaging and involving a host of other Partners who can offer more local opportunities to tailor and target materials and deliver professional capacity building. This includes expanding "Technology Transfer" activities through LTAP Centers and the professional associations. 	<p>PCB Partners fully engaged in the roles they have defined for themselves in ITS training and education. Successful engagement can be evaluated by the following criteria:</p> <ul style="list-style-type: none"> The NHI and NTI operate in conjunction with FHWA and FTA in developing and delivering ITS courses; LTAP Centers have become an integral part of the ITS program; FHWA Resource Centers and Division Offices and FTA Regional Offices have fully trained staffs to offer training and technical assistance; FTA Regional Office staffs working with FHWA Resource Centers to provide training and technical assistance to partners. Universities throughout the country offer multi-disciplinary graduate transportation programs; Universities have established extensive education programs and curricula, providing the basic education for new entrants to the public and private sector. A network of university-based "ITS Institutes" functions throughout the country to intensively train and mainstream middle management/technical professionals. Junior colleges and technical schools develop and present technician training programs to meet transportation needs, and they provide a source of students for universities. Private sector transportation companies work with U.S. DOT and universities to coordinate, develop, and deliver various curricula to meet industry needs; The private sector has established a "curriculum" and is providing extensive, hands-on training. Professional associations have established clear lines of interaction with U.S. DOT to develop and deliver training courses that meet high priority needs, and to develop ITS curriculum and certification programs that meet the needs of their memberships.

5) Increase PCB Program Communications and Outreach

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
<ul style="list-style-type: none"> Articles published in Public Roads, ITS America, DOT newsletter describing the goals and efforts of the ITS PCB Program. Developed three separate catalogs of ITS training and education courses: <ul style="list-style-type: none"> ⇒ The U.S. DOT ITS PCB Catalog which includes NHI, NTI and OMC offerings. ⇒ The Catalog for Intelligent Transportation Systems Education and Training Efforts at U.S. Universities. ⇒ The ITS Supplier Course Catalog which includes private sector and vendor-based training. Numerous university web-sites established that link students, faculty, researchers, and transportation professionals to ITS educational opportunities at universities. Numerous presentations on ITS training, education and the PCB Program delivered around the nation, including to the Cxx for University Transportation Centers (CUTC) 	<ul style="list-style-type: none"> Development of the ITS PCB web site. Frequent PCB Program updates provided through the ICDN newsletter. Forum on the future of transportation education and future professionals held at the annual TRB meeting. 	<ul style="list-style-type: none"> A more proactive “marketing” of the availability of training to partners and through the PCB Program partners to their memberships, especially universities to reach prospective students. ITS America in co-operation with its members, universities, training institutions, and U.S. DOT is initiating an ITS America Education & Training Program designed to result in the award of an ITSA Certificate of Study in ITS Technologies. 	<ul style="list-style-type: none"> University undergraduate transportation programs attract increasing numbers of students to transportation majors

6) Continuously Improve the PCB Program

FY 1996-1998: Accomplished	FY 1999: Underway	FY 2000: Planned	FY 2001-2002: Proposed for Mainstreaming
<ul style="list-style-type: none"> Initial evaluation methods included analyzing student feedback through questionnaires at the end of training sessions. 	<ul style="list-style-type: none"> Developing U.S. DOT strategies to become a continuous learning organization. Revising existing ITS PCB training and classroom delivery methods to include ISD principles. 	<ul style="list-style-type: none"> Continued revision of existing ITS PCB training and classroom delivery methods to include ISD principles of learning. Web site to be developed with feedback mechanism to answer questions in a timely manner and to capture the following types of information: <ul style="list-style-type: none"> Student proposals for revisions and up-dates to web-based training, Desired new training needs and initiatives Track the characteristics of users (e.g., type of agency, job level) Track whether web-based courses meet student's needs. 	<ul style="list-style-type: none"> Begin to "sunset" the U.S. DOT PCB program Transition completed to phase out of U.S. DOT PCB program Continuous learning environments have been established at U.S. DOT, among State and local agencies and in the private sector.

APPENDIX D: REPORT

BUILDING PROFESSIONAL CAPACITY IN ITS: GUIDELINES FOR STAFFING, HIRING, AND DESIGNING “IDEAL” PROJECT TEAMS

BUILDING PROFESSIONAL CAPACITY IN ITS:

GUIDELINES FOR DESIGNING AN INDIVIDUALIZED TRAINING AND EDUCATION PLAN



US Department of Transportation
ITS Joint Program Office
ITS PCB Program

April 1999

Foreword

This report summarizes a comprehensive effort conducted in the summer of 1998 to more systematically investigate the intelligent transportation systems (ITS) training and education needs of transportation professionals. A team of analysts conducted a series of nearly 200 interviews in an effort to obtain a more detailed understanding of the underlying fundamental knowledge and skills required in support of ITS applications and services. The interviewees spanned a range of ITS involvement from those actively engaged for several years, to those just beginning the process. Thus, the reported needs reflect an important “grass-roots” perspective obtained from the public-sector, private-sector, and the academic community.

This report documents the wide-ranging ITS training and education needs of transportation professionals. An analysis of those needs resulted in the development of a PCB Program strategy to meet those needs both now and in the future. Although the focus of this work is ITS, the analysis also revealed that the fundamental knowledge and skills are applicable to a wider audience of transportation professionals engaged in the operation and management of multimodal surface transportation systems.

The ITS PCB Program is comprised of a partnership of organizations which work cooperatively to provide ITS professional capacity building. That partnership encompasses the public sector, the private sector, and the academic community. It is hoped that this report will be used as a foundation for ongoing dialogue with the multiple partners, stakeholders and transportation professionals everywhere about:

- The process of building professional capacity for ITS;
- The design and delivery of training and education programs that achieve the level of competency required for meeting the challenges of 21st century transportation systems; and
- The most effective and cooperative programmatic ways to meet training and education needs in ITS.

Thomas F. Humphrey
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Coordinator of the U.S. DOT's ITS Professional Capacity Building Program
ITS Joint Program Office, Washington D.C.
April, 1999

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- The Volpe National Transportation Systems Center (VNTSC)
- The Federal Transit Administration's ITS Program
- The Federal Highway's National Highway Institute (NHI) and Office of Personnel and Training.

The VNTSC project director was Suzanne M. Sloan, assisted by Mary Susan Sparlin of NHI. Key staff support from the Volpe Center was provided by Robert Brodesky, Joseph LoVecchio, Maureen Luna - Long, John O'Donnell, Douglas Rickenback, and Margaret Zirker.

The authors wish to thank the many individuals, located across the country, who took the time and made the substantial effort to arrange for the staff interviews that were so critical to this effort. Also, thanks is gratefully extended to the nearly 200 interviewees and the training and education experts who were willing to be interviewed and whose excellent contributions of information and guidance have greatly benefited our work.

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Overview: Introduction

Purpose of this Document

This document is a guide for transportation professionals on how to create an individualized training and education plan for enhancing their knowledge and skills for working with ITS. The guide identifies the twenty “ideal” roles that professionals play in ITS and the ITS competencies required for successful performance in each role. Based on these roles and competencies, the guide then presents a curriculum that has been designed to build the competencies recommended for each individual role.

The twenty sets of ITS Curricula recommend training and education courses that are available from three categories of sources: the U.S. DOT training programs, the academic community, and private sector professional associations and vendors. The guide relies upon the reader to make some personal determinations for future development either on his/her own, with a supervisor, and/or with human resources staff:

- (1) The first determination is what role or roles the reader plays in ITS. Many people function in more than one role and therefore need to build a cross-section of ITS competencies.
- (2) The second determination is the level — awareness or specialized — at which the reader currently possesses an understanding of one or more of the ITS competencies. Many professionals have already acquired some level of ITS competence through:
 - Previous education or background experience;
 - Involvement in planning or deployment activities;
 - Self-development by attending conferences, reading journals or participating in ITS committees; or
 - Attending some of the ITS PCB training courses or other courses.
- (3) The third determination is how to go about building the required ITS professional capacity. This will require the reader to develop an individualized plan for learning. It requires the commitment of the reader to determine his/her existing strengths, identify what knowledge areas require further exploration, and pursue those resources which will help bridge his/her knowledge gaps.

The guide is intended to satisfy the needs of professionals who are in search of a greater understanding and awareness of ITS, and for those who want to develop a specialized area of knowledge that will advance their contribution to ITS-related projects. It does not provide recommendations for building professional expertise that comes only through years of study and experience. Instead, the guide is intended to help professionals who have discovered that the requirements of their jobs have changed, want to successfully meet the technological and institutional demands of ITS-related projects, and are interested in advancing their careers in ITS. It also recognizes that the level of knowledge or the extent of any one's contribution will vary depending on the person's role and the composition of the team that is gathered during the different stages of the ITS project.

Overview: Background

What Is ITS Professional Capacity Building

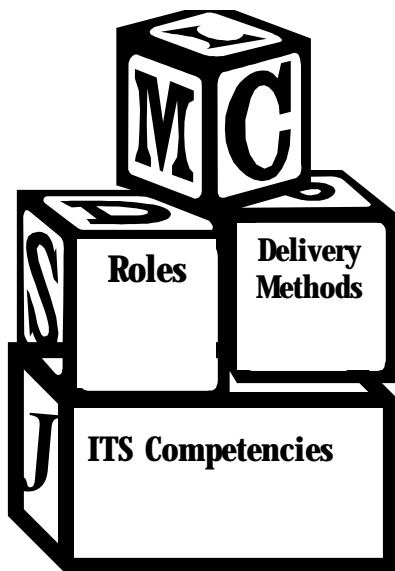
Professional capacity building (PCB) is the process of developing new or enhancing existing knowledge and skills that are required for successful performance in one's job. ITS professional capacity building has been growing in importance since 1991 when Congress charted a new course for the modernization of the country's surface transportation system. The intent of ITS is to achieve greater operational safety and management efficiency by enhancing surface transportation systems with electronics, communications, computer and sensing technologies, known as Intelligent Transportation Systems or ITS.

The move towards applying ITS to surface transportation requires transportation professionals at all levels to incorporate and apply new competencies in their daily work activities. The recent technological revolution in the areas of electronics, telecommunications and computing requires transportation professionals to search for, and access, education and training resources which will enable them to remain professionally current.

This guide highlights the process of building professional capacity for ITS. It uses information gathered from nearly 200 interviews with transportation professionals engaged in ITS around the nation in the summer of 1998. These professionals represented a wide variety of responsibilities and functions in public and private sector transportation agencies and organizations. More detail on these interviews is published in a separate report entitled, *Building Professional Capacity in ITS: Documentation and Analysis of ITS Training and Education Needs in Support of ITS Deployment* (available on the ITS PCB web site at <http://www.its.dot.gov>), which also documents how the U.S. Department of Transportation (DOT) and its PCB partners are addressing ITS professional capacity building needs.

The PCB Building Blocks

For a professional who wants to determine how to build his/her own ITS professional capacity, he/she will need to begin with an understanding of the three PCB "building blocks". Briefly, they are:



- **ITS Roles** — the range of ideal ITS functions and job positions within a transportation agency and/or on an ITS project team.
- **ITS Competencies** — bundled sets of applied knowledge and skills that support successful job performance in ITS.
- **Delivery Methods** — the most accessible ways for professionals to learn about ITS; the ITS PCB Program relies on methods in four categories — training, education, technical assistance, and information dissemination.

Two of these building blocks are used in designing the individualized ITS training and education plans — the roles and the ITS competencies. The third, delivery methods, is described in this report to help professionals identify the most accessible means for

them to receive PCB, and then to request that form of delivery from the PCB program and other PCB providers. The following describes each building block in greater detail.

Range of ITS Roles

The needs assessment study cited above defines twenty “ideal” ITS team roles that professionals perform in ITS. Frequently, professionals play more than one role in their jobs. Additionally, the scope of each role varies among agencies and ITS projects.

The interviews revealed that, in deploying ITS, the most effective performance resulted from dividing the competencies among a team of people and employing them with a strategy similar to the use of a football team’s members throughout a game. In this respect, no one person has to know it all. Instead, each role varies in its competency mix to allow professionals to focus on those areas that are most important for their job functions.

Unfortunately, the majority of transportation agencies are not always in a position to staff these roles due to limitations on hiring, salary caps, and the move toward privatization. A separate companion guide entitled, ***Building Professional Capacity in ITS: Guidelines for Staffing, Hiring, and Designing Ideal Project Teams***, is available on the ITS PCB web site (<http://www.its.dot.gov>) to help managers and agency decision makers identify and decide how to staff the role(s) of the intra- and inter-agency team members.

The ITS roles are listed in Table 1. In structuring an individualized ITS training and education plan, the reader should either individually or with his/her supervisor and/or human resource development personnel, identify the role(s) played. To help, more detail on each role and its responsibilities is provided at the beginning of each curriculum, located on pages 9-55 of this guide.

Table 1: Range of ITS Roles

<u>Roles in Developing a Regional ITS Concept of Operations and Planning for ITS</u> <ul style="list-style-type: none"> • Champions • Planners • Federal Field Staff 	<u>Cross-Cutting Roles</u> <ul style="list-style-type: none"> • Business Analysts • Data(base) Analysts and Managers • Contract Specialists • Legal Staff • Marketing / Public Relations Staff • Human Resources Staff • Systems Administrators/ Support Technicians
<u>Roles in the Design, Procurement, Installation, Operations & Maintenance, and Evaluation Stages</u> <ul style="list-style-type: none"> • Project Managers • Software Developers • Systems Designers / Integrators • Operators • Dispatchers • Drivers • Electronics Inspection and Maintenance Technicians • Operations Managers/Supervisors 	<u>Creating Change: Roles for Mainstreaming ITS</u> <ul style="list-style-type: none"> • Program/Agency Manager • Inter-jurisdictional Coordinator

ITS Competencies

An ITS competency is a *bundled set of knowledge and skills* that support successful job performance. Knowledge provides the fundamental principles associated with the competency area, and skills help one learn how to apply the knowledge.

Table 2 presents the competencies in four general categories, which characterizes when ITS competencies are needed and why. The competencies in bold and that are ranked, represent the top ten needs in ITS learning. The rankings derive from a series of nearly 200 interviews that were conducted as part of the needs assessment. Twenty-seven ITS competency areas have been defined that encompass the fundamental technical and institutional knowledge and skills required across the ITS stages of project planning, design and deployment and through systems operations, maintenance, and ongoing management.

Detailed descriptions of each of these competencies can be found beginning on page 57 of this guide.

Table 2: Range of ITS Competencies

<p><u>Competencies for Developing a Regional ITS Concept of Operations and Planning for ITS</u></p> <ul style="list-style-type: none"> • ITS Awareness/ITS Topics (see below) • Identifying Stakeholders/Building Coalitions (9) • National ITS Architecture • Partnerships • Financing (6) • ITS Planning (8) 	<p><u>Cross-Cutting Competencies</u></p> <ul style="list-style-type: none"> • Project Management • ITS Legal Issues • Marketing/Public Relations • Writing/Communications (7) • Problem Solving • Data Analysis & Management (10) • Transportation Fundamentals
<p><u>Competencies for the Design, Procurement, Installation, Operations & Maintenance, and Evaluation Stages</u></p> <ul style="list-style-type: none"> • Systems Analysis & Design (4) • Technology Options (3) • ITS Standards • Software and Hardware Operations • Software Development • ITS Human Factors • Procurement • Managing Contractors (5) • Systems Integration (1) • Project Evaluation • Operations • Systems Support and Maintenance 	<p><u>Creating Change: Competencies for Mainstreaming ITS</u></p> <ul style="list-style-type: none"> • Legislative and Policy Change • Organizational/Institutional Change (2) <p><u>ITS Topics:</u></p> <ul style="list-style-type: none"> • Freeway Management Systems • Incident and Emergency Management Systems • Advanced Traveler Information Systems • Advanced Public Transportation Systems • Advanced Traffic Signal Control Systems • Electronic Fare Payment Systems • Electronic Toll Collection Systems • Highway-Rail Intersection Systems • Commercial Vehicle Operations/CVISN • Rural ITS systems

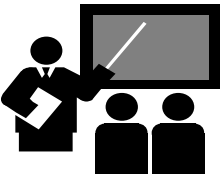



Range of Delivery Methods for Learning ITS

The four primary means of delivering professional capacity building are **training, formal education, technical assistance, and information outreach**. Professionals need to consider what means of learning is most accessible to them. Table 3 provides a more comprehensive list of the methods available for delivering ITS learning that are used by the U.S. DOT and its PCB partners.

The interviews revealed that *the method by which one learns is equally as important as identifying one's role and what one needs to learn*. In today's fastpaced business environment, the more traditional methods of learning, such as training courses or pursuing educational classes, don't always meet the needs of professionals who need information and instruction on -the-job and just-in-time.

In addition, the interviewees made it evident that professionals who were most successful at learning about ITS did so through a wide variety of learning methods. They mixed night -time courses at local universities (education) with constant reading of journals, attendance at conferences, and participation on committees (information outreach). They participated in ITS Scanning Reviews, arranged their own visits to sites with ITS deployments, and called peers about problems, solutions, and experiences (technical assistance). In fact, many of the interviewees were some of the first attendees of the U.S. DOT's PCB Program's ITS courses and seminars (training).

Table 3: Range of ITS Delivery Methods

<p><u>Training</u></p> <ul style="list-style-type: none">• Traditional classroom style• Computer-based training (CBT)• Satellite broadcast of a course presentation• Web-based training (WBT)• Job rotation or exchange program through/with agencies, professional associations, or private sector firms. 	<p><u>Education</u></p> <ul style="list-style-type: none">• University and college semester lecture courses, labs and degree programs.• Certificate programs for continuing education• Technical and vocational school courses, labs, and degree programs• Journeyman and apprenticeship programs 
<p><u>Technical Assistance</u></p> <ul style="list-style-type: none">• Assistance from Federal Field Staff• Mentoring• Peer-to-Peer Network• Consultant/Contractor assistance• Scanning Reviews 	<p><u>Information Outreach</u></p> <ul style="list-style-type: none">• Web site with reports, information and access to technical assistance• Papers on best practices, lessons learned, and successful approaches• Vendor sponsored programs: displays, exhibits, training, Electronic Data Library, Electronic newsletters. 

It is the goal of the ITS PCB Program to utilize the delivery method that most effectively allows the learning to be *tailored to, targeted for, and accessible to* professionals.

“The goal of a 21st century professional capacity building program should be to provide *the right information to the right people at the right time and place, as quickly and conveniently as possible.*”

An interviewee

Steps For Building ITS Professional Capacity

What competencies are needed and at what level, is unique to each individual. Also, the level at which a professional will need to learn an ITS competency is dependent upon the role, or roles, that he/she plays within a transportation agency and/or on an ITS project. The remainder of this document provides tools for individual transportation professionals to determine how to build their own professional capacity in ITS. These tools are:

- A series of **ITS curricula** that recommend, for each role, a sequence of learning.
- A **set of definitions for each competency** that also lists the training, education, technical assistance, and information references that are available to build professional capacity in each competency area.

This document recommends a four step process using these tools for professionals to follow in determining for themselves their own unique mix and learning sequence of professional capacity building in ITS competencies:

- 1) **Step One: Identify your role(s)**
- 2) **Step Two: Determine your current level of ITS competencies**
- 3) **Step Three: Use the ITS Curricula to develop a learning plan**
- 4) **Step Four: Use the definition pages to learn of additional training resources and opportunities**

Step One: Identify Your Role(s)

To begin, use the chart on page 3 to identify what role or roles you perform for your transportation agency or on your ITS project. You may play more than one role and will thus need to combine the curricula when forming a learning plan.

Step Two: Determine Your Current Level of Competencies

After identifying your role, turn to the ITS Curricula listed on pages 9 through 55. For each role, a description of the functions and responsibilities is provided for the reader to ensure the right match to the role. A list of competencies is then recommended to build the ITS competence needed for that role.

At this point, the reader will need to determine his/her current level of ITS competence. It may be that through experience or through education, the reader already possesses the recommended level of one or more competencies. It may also be that the recommended competencies need to be expanded or minimized based on the reality of the reader's role. The key to this step is for the reader to determine the gap that still needs to be filled through further ITS training and education.

Step Three: Use the ITS Curricula to Develop a Learning Plan

The next step is for the reader to consider the curriculum associated with his/her role. If the reader plays more than one role, the curricula will need to be combined. The curricula are designed around U.S. DOT training and education courses and seminars, including those developed by the ITS PCB Program, the National Highway Institute (NHI) and the National Transit Institute (NTI). They also include courses from PCB Program partners such as universities, ITS America (ITSA) and the Institute of Transportation Engineers (ITE).

The curricula provides a sequence for learning at the awareness level and at the specialized level, which are associated with the competency recommendations. The **Awareness Level** provides training to build a basic sense of awareness with an ITS topic or an associated topic, and an overview of the issues and experiences-to-date. The **Specialized level** provides more in-depth knowledge to build a fundamental foundation to many of the principles involved in ITS, and skill-building instruction to provide “how-to” learning for many of the skills needed for ITS.

When using the curricula, it is important to consider how much ITS learning you may already have acquired either on-the-job or in training. The new entrant to ITS will want to begin with the Awareness Training Curricula. Those professionals who have been engaged in ITS for a while may find it more appropriate to begin at the Specialized Level.

Step Four: Use the Definition Pages to Learn of Additional Resources and Opportunities

Other learning resources and opportunities are available. These resources are a mix of training, education, technical assistance and information that can be accessed through the U.S. DOT and its Electronic Document Library (EDL), local universities and LTAP Centers, professional associations, and private sector vendors.

Other resources that complement this learning are listed according to competency areas on pages 57 through 113. These pages list the type of courses one should seek out at local universities, Technical Assistance programs that are available and accessible, and information resources both on the Internet and by hard copy.

Not every resource is listed due to time limitations on identifying them. Thus, the reader is expected to explore other catalogs that are available that provide additional and up-to-date information. These other catalogs can be found through professional associations, local universities, State DOT training programs, or vendors and also on web sites. The definition pages include the more obvious opportunities as a way to provide direction for thinking about other opportunities.

*** It should be noted that, what is missing from both the ITS Curricula and the definition pages, is a level of learning that qualifies a professional to be an expert. For most roles, this expert, “nitty-gritty” background is inherent within the job requirements for the role. For instance, success comes easier if you hire a Marketer for marketing or a Systems Designer for designing your system. The training and education recommended through Awareness and Specialized training would not provide these skills at that level. Instead, the ITS curricula introduce, establish and provide a sound foundation for professionals to enhance their knowledge and skills for working with ITS.

Conclusion

This guide has been developed so that it is practical and easy to use in developing individualized ITS training and education plans. The professional who is seeking a greater ITS awareness, as well as the individual seeking more specialized ITS knowledge and skills can follow the steps outlined in this guide to develop an action plan for securing the training and education required by ITS projects and activities.

The curricula are provided in this guide to assist professionals in building a foundation in ITS. They are not meant as a checklist, nor a certification. ITS competence evolves as the training and education recommended here is supplemented with practical, hands-on knowledge and experience. However, to begin building that foundation, this guide provides the following tools:

- ITS roles to help the reader identify his/her functions and responsibilities;
- ITS competencies to help the reader determine what knowledge and skills are needed;
- A set of ITS Curricula to assist the reader in developing a plan for learning;
- Competency definitions that also describes further opportunities to access learning through training, education, technical assistance, and information outreach.

The ITS Curricula

The remainder of this guide contains the ITS curricula for each ITS role and the definition pages. They both utilize the following set of symbols to identify training and education opportunities:

- ✓ **Specific ITS training courses** that have been developed and are known to be available through the following ITS PCB Program partners: U.S. DOT, the National Highway Institute (NHI), the Federal Highway Administration (FHWA), the National Transit Institute (NTI), the Federal Transit Administration (FTA), the Institute of Transportation Engineers (ITE), and ITS America (ITSA). These courses are noted through the document with a checkmark (✓). A notation is also made to denote suggested reading materials that are available on the ITS EDL.
- * **Suggested general training and education** courses that have been identified as available through universities, vendors, professional associations, and/or available through other U.S. DOT programs. These courses are identified throughout the document with a star (*).
- ◇ **Recommendations for training courses that have not yet been identified** as available. These courses may exist, or may still need to be developed. These courses are identified by an unfilled diamond (◇). The listing of these courses also provide direction for PCB Program partners who are planning to develop new training and education.

The curricula are designed to be broad enough to include staff at both public sector highways and transit agencies and the private sector contractors. If courses have already been targeted for a highway or transit perspective, both are noted in the same box with an “or” to signify that either course will accomplish the same objective. When the public highway or transit role or private sector role differs enough, separate curriculum are provided.

ITS Curriculum — ITS Champions

Role Description: ITS Champions are also known as Advocates. They are individuals who promote the benefits of ITS to decision makers — both elected (legislators) and appointed (agency heads), to the internal staff at their agency and at other agencies, and to the public. In some respect, everyone involved in ITS needs to play this role. There are many documented examples of why this role is so important. To play this role effectively, it requires an in-depth awareness of ITS, and an ability to communicate effectively with political, executive, management and technical staff. Champions frequently have to spearhead organizational/institutional and legislative and policy changes to allow ITS deployments to occur.

The Champion role has been formalized within the ITS Commercial Vehicle Operations program, though the role exists informally within the ITS Metropolitan deployment program. It was noted throughout interviews that at leading-edge sites, there was a champion who was continually referred to as having promoted a guiding vision of ITS deployment. It was also noted that many project managers played the champion role within their agencies or on their projects. Across the interviews, this was described as a critical role.

Once the decision to deploy ITS has been made, the Champion plays an important role in building awareness and mainstreaming ITS. The typical background of a Champion is many years of experience in the transportation industry. This is important to be able to understand how all the various agencies, officials, and decision-makers play roles and have opportunities and limitations to their roles. Champions are charismatic, good communicators and negotiators, and usually politically well connected.

Functions and Responsibilities:

- Acts as a visionary who recognizes ITS as a tool for better operations and management of the transportation system, and meeting customer needs.
- Plays a role in building ITS awareness in other professionals who will make decisions.
- Is actively involved in planning and deploying ITS.
- Promotes and markets the benefits of ITS to other professionals; builds awareness in other transportation decision makers outside of the ITS deployment process in an effort to mainstream ITS concepts and terminology.
- Facilitates building a regional ITS vision among the various stakeholders.
- Helps identify roles that agencies and professionals will play in deployment, and provides information for deployment and operating decisions.

The following is a list of the recommended competencies to build the breadth required for an ITS Champion:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Technology Options (3) System Analysis and Design (4) National ITS Architecture ITS Standards Partnerships Marketing/Public Relations	Organizational/Institutional Change (2) Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Problem Solving Transportation Fundamentals

Recommended Core Training and Education for ITS Champions

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	Technology Options: Depends on the type of ITS project
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT) or ✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	ITS Topic Specific: Depends on project type
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	* Course in change management (business schools, universities, professional associations)

ITS Curriculum — Planners

Role Description: The role of the Planner exists both within transportation agencies and at Metropolitan Planning Organizations (MPO). Although these roles embody slightly differing functions and perspectives, the competencies are similar. Planners must be able to identify ITS opportunities, and evaluate them in the context of regional and agency goals and objectives, and determine the potential for their integration in capital improvement projects.

Planners at MPOs play an important role in integrating ITS projects into regional planning documents, thereby mainstreaming ITS into ongoing transportation planning. The most common ITS functions of the MPO planner role is to provide outreach and coordination with local transportation agencies to: demonstrate ITS and its benefits; promote the MPO as a forum for developing a regional ITS vision; sponsor multi-jurisdictional, multi-agency, and multi-discipline ITS committees; and serve as a link to policy makers and the private sector. **Planners at transportation agencies** play a role in integrating ITS projects into an agency's yearly transportation plans. ITS from this perspective is frequently mode-specific. Agency planners play a role in representing agency needs when building the regional ITS vision. They work with Project Managers to plan and design the agency's ITS projects and activities and they assist in ensuring that ITS projects have funding. They assist the agency with their familiarity with all applicable planning and environmental regulations.

Functions and Responsibilities:

- Understand funding mechanisms and processes, and be able to leverage financial resources in a strategic way for multiple agency benefit.
- Work cooperatively within a regional and political environment to build consensus on an ITS vision; help write Early Deployment Plans or ITS Plans.
- Compile ITS benefits; market ITS to senior decision makers and elected officials.
- Incorporate ITS projects into existing transportation planning documents, including Regional Transportation Plans, TIP, CMS, MIS, etc.
- Provide technical expertise in incorporating ITS into the planning process, GIS mapping, modeling, and forecasting.
- Help plan current and future expansion of operations.
- Research technology options and educate senior decision makers, elected officials, and project managers.
- Track ITS infrastructure already deployed.
- Assist in promoting multi-jurisdictional, multi-agency, multi-discipline, and project integration; help form partnerships among transportation agencies and between the public and private sector.
- Conduct studies on capacity, flow, and impact of ITS projects on surrounding jurisdictions.

The following is a list of the recommended competencies to build the breadth required for Planners:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Organizational/Institutional Change (2) Technology Options (3) Systems Analysis and Design (4) ITS Standards Marketing and Public Relations Project Evaluation Legislative and Policy Change ITS Legal Issues Operations	Managing Contractors (5) Financing (6) Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Data Management and Analysis (10) National ITS Architecture Project Management Partnerships Procurement Problem Solving Software and Hardware Operations

Recommended Core Training and Education for ITS Planners

Awareness Training

- ✓ ITS Awareness Seminar (NHI or internet: <http://www.nawgits.com/nawg/itsaware/>) or
- ✓ ITS in Transit (FTA)
- ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or
- ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
- ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: <http://www.its.dot.gov/pcb/deploygd.htm>)
- ✓ Deploying Integrated ITS — Rural (NHI)
- ✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
- Technology Options: Depends on the type of ITS project
- For Transit Planners:
 - ✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)
- ✓ ITS Telecommunications Overview (NHI)
- * Introductory course on the software development process (U.S. DOT, vendors and universities)
- * Introductory course on systems engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools)
- * Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
- * Course in marketing/public relations basics (universities, junior colleges)
- ✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
- ◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.
- ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.
- * ITS America's Legislative Affairs web-site. (<http://www.itsa.org/legislative.html>)

Specialized Training

- ✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
- ✓ ITS and the Transportation Planning Process (NHI)
- ✓ ITS Public/Private Partnerships (NHI)
- ✓ Shared Resources for Telecommunications (NHI)
- ✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
- For Transit Planners:
 - ✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI) and
 - ✓ Reinventing Transit: Planning Information-Based Transit Services (NTI)
- ✓ Managing Systems Integrators (ITSA)
- ✓ Lessons Learned in ITS Procurement (NHI)
- ✓ ITS Telecommunications Analysis (NHI)
- ✓ ITS Software Acquisition (NHI)
- ✓ Use of CORSIM Computer Traffic Simulation Model (U.S. DOT)
- ◇ Other models as they become available
- * Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
- * Course in procurement and legal issues (U.S. DOT)
- * Courses on data analysis, management and databases (universities)
- * Course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
- * Courses on project management (U.S. DOT, universities and junior colleges)
- * Advanced course in negotiations (U.S. DOT, universities, professional associations)
- * Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
- ◇ Seminar on ITS Legal Issues.

ITS Curriculum — Federal Field Staff

Role Description: The primary role of Federal Field Staff is to transfer information on ITS policy and ITS funding availability, and to provide technical assistance to state, regional, and local public sector transportation agencies. Both FHWA and FTA have designated individuals as ITS field specialists, many of whom have or are developing a technological background that will allow them to take a proactive advisory role when providing technical assistance to state, regional and local agency staff. FHWA has recently reorganized its nine regional offices into four Resource Centers with four ITS specialist positions at each center. FHWA Division Offices have a designated ITS staff member but it varies as to whether they function in full- or part-time capacity. The predominant difference between these two offices is that there appears to be a greater responsibility for Regional staff to coordinate and leverage experiences across the multiple deployments within a region, and a greater and more detailed focus by the Division office staff on State and local matters. FTA has designated one person in each of its ten Regional Offices to act as point-person for ITS questions and issues. This is in addition to other duties and frequently the FTA ITS Specialist functions on a part-time basis.

Functions and Responsibilities:

- Advise on the federal funding and the grants process as it applies to ITS projects; identify sources of funding.
- Work with state, regional and local transportation agency staff to identify local stakeholders, to form coalitions and private-sector partnerships, and establish peer-to-peer connections and mentoring opportunities; provide marketing support to engage non-traditional stakeholders as part of the conceptual design process.
- Have familiarity with state/local procurement requirements to help leverage local technology purchases; facilitate coordination of equipment and service needs of different agencies within a region as they move forward with deployments.
- Provide information for evaluating technology options including “tried-and-true” versus “leading-edge”; form relationships with vendors to provide information on costs, benefits, functionality; distribute cost/benefit evaluations of existing deployments; provide ITS training with best practices, successful approaches, and lessons learned in cooperation with local PCB partners such as universities and LTAP centers.
- Track regional, state and local deployment; track changes in project funding and scope.
- Participate in design of performance measures with transportation agencies for project testing and evaluation.
- Promote and market ITS to senior decision makers at state and local agencies, other federal transportation staff, local elected officials, and planners.
- Provide guidance on National ITS Architecture conformity and standards as part of the planning and design process for ITS projects.
- Develop/maintain working relationships among FHWA, FTA and OMC field offices to further project integration.
- Identify contractor’s expertise and provide assistance with qualifying them for state, regional, and local transportation agencies.
- Provide guidance and assistance on flexible funding, for example with FHWA and FTA funding transfers for joint projects.
- Extend audiences to include municipal and county transportation agencies; work in closer partnership with MPOs on promoting ITS and regional coordination among operating agencies.

The following competencies are recommended to build the breadth required for Federal Field Staff:

ITS Curriculum — Federal Field Staff (cont'd)

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Organizational/Institutional Change (2) Technology Options (3) Systems Analysis and Design (4) Financing (6) Writing/Communications (7) ITS Planning (8) Data Analysis and Management (10) Procurement Project Evaluation Operations	Building Coalitions (9) National ITS Architecture ITS Standards ITS Legal Issues A specialty in an ITS technology area such as software development, telecommunications, electronics, or systems engineering

Recommended Core Training and Education for FHWA Resource Center and Division Office ITS Specialists

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course on data analysis, management and databases (U.S. DOT, universities)
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS and Human Factors (JPO)
	* Introductory course on software and human factors (universities)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.
	◇ Workshop on using and writing ITS contracts and ITS specifications
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ Standard Training Modules (U.S. DOT)
	✓ Advanced Transportation Management Technology Workshop (FHWA)
	✓ Managing Systems Integrators (ITSA)
	✓ ITS Software Acquisition (NHI)
	✓ Shared Resources for Telecommunications (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)
	ITS Topic Specific:
	✓ Freeway Management Systems (NHI)
	✓ Incident and Emergency Management Systems (NHI)
	◇ Advanced Traveler Information Systems
	✓ Advanced Signal Control Systems (NHI)
	◇ Electronic Toll Collection Systems
	◇ Highway-Rail Crossings
	Advanced Technology Options:
	✓ Traffic Surveillance Systems (ITSA)
	✓ Freeway Traffic Operations (NHI)
	✓ Traffic Control Software and Signalization (NHI)
	✓ Computerized Traffic Signal Systems (NHI)
	✓ Advanced Traffic Signal Controllers (NHI)
	✓ HOV Facilities (NHI)
	✓ Advanced Sensors (ITSA)
	✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT)
	◇ Use of other models as they become available.
	* Advanced course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in procurement and legal issues (U.S. DOT)
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)
	◇ Seminar on ITS legal issues

Recommended Core Training and Education for FTA Regional Office ITS Specialists

Awareness Training	✓ ITS in Transit (FTA)
	✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course on data analysis, management and databases (U.S. DOT, universities)
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS and Human Factors (JPO)
	* Introductory course on software and human factors (universities)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.
	◇ Workshop on using and writing ITS contracts and ITS specifications
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Transit Management Course (FTA)
	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ Standard Training Modules (U.S. DOT)
	✓ Procuring New Technologies for Transit (NTI)
	✓ Managing Systems Integrators (ITSA)
	✓ ITS Software Acquisition (NHI)
	✓ Shared Resources for Telecommunications (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)
	ITS Topic Specific:
	✓ Advanced Public Transportation Systems (FTA)
	◇ Advanced Traveler Information Systems
	◇ Electronic Fare Payment Systems
	◇ Fleet Operations and Maintenance Systems
	Advanced Technology Options:
	✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI)
	✓ NTI Workshops on Advanced Technologies and Innovative Practices for Transit (NTI)
	✓ Geographic Information Systems: Transit Applications (NTI)
	✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT)
	◇ Use of other models as they become available.
	✓ Reinventing Transit: Planning Information-Based Transit Services (NTI)
	✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)
	* Advanced course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in procurement and legal issues (U.S. DOT)
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)
	◇ Seminar on ITS legal issues

ITS Curriculum — Project Managers

Role Description: The role of the Project Manager is a primary and significant role in ITS deployment. It requires one of the more comprehensive ranges of breadth and depth in ITS competencies.

ITS Project Managers activities frequently begin in their role at the planning and design stages of ITS projects and continue through the selection of staff and contractors, procurement, deployment and installation activities. Some Project Managers begin in the Champion role and are instrumental in the decision to deploy. Others begin once the decision to deploy has been made by senior Policy/Agency Managers. Once deployed and functional, Project Managers either transfer the working system's operations to an Operations Managers or become the Operations Manager.

ITS Project Managers must have a solid understanding of the transportation industry and the goals and functions of their agency. They must understand the problems that deployed systems are expected to resolve, and a detailed knowledge of how to apply ITS technologies. They are responsible for ensuring the deployment is carried out effectively and successfully through staff and contractors, which requires an understanding of how ITS fits into the on-going capital improvement construction process and existing operations.

Functions and Responsibilities:

- Manage ITS project deployments from design to operations, including:
 - Identify and involve all stakeholders in the system conceptualization and design, including other transportation agencies, non-traditional transportation agencies such as police, emergency and tow truck personnel, and other concerned groups.
 - Conduct/oversee user needs assessment as part of design process; understand data needs and flows.
 - Involve non-traditional but necessary staff and eventual users in the design and decision making, e.g., electronics technicians, operators, dispatchers, systems maintenance and support staff, and external agency team members.
 - Determine scope of deployment using analysis tools such as investment analysis, impact analysis, or cost/benefit analysis.
 - Apply National ITS Architecture and Standards to project design.
 - Participate in technology selection and procurement; help prepare RFPs; determine technology and systems specifications.
 - Provide project oversight of software development; work closely with developers.
 - Staff/contract for and schedule project deployment activities; coordinate work with ongoing construction activities.
 - Select and manage contractors, their schedules and delivery milestones.
 - Secure financing/funding, manage grants, prepare budgets, track expenses.
 - Manage installation and integration, including prototyping, testing and evaluation stages.
 - Conduct periodic evaluations throughout the project cycle and lead final project inspection, testing and evaluation.
 - Design and plan for operations staff, and support and maintenance staff.
- Ensure that the project is being deployed in tandem with other projects and assist with integration, including defining tests and performance measures that provide evidence of proper integration.
- Keep senior Policy/Agency Managers informed of progress and engage their assistance for institutional/organizational or legislative changes.
- Work with inter-jurisdictional coordinator to account for impact on surrounding jurisdictions.

The current Project Manager role differs markedly from the past. First, ITS planning, deployment and installation activities require different staff and staffing qualifications. Second, ITS projects tend to be less discrete than capital improvement projects; they tend to follow an iterative prototyping and testing process and frequently “bleed” into ongoing operations, thus requiring staff to work interdependently. In addition, ITS projects typically do not have clearly identified measures of performance that signify success.

The Project Manager plays a key role in helping to define those measures of performance. Each project requires a team of managers, engineers, analysts and technicians to envision what is feasible, what the requirements are, and what the results should be.

For the most part, the public and private sector Project Managers require similar competencies and backgrounds. Some of the more pronounced differences are:

- Private sector Project Managers are expected to have a more well-developed technical expertise in one or more of the competency areas of information technologies, systems integration and engineering, telecommunications, or software development. As such, the private sector Project Manager curriculum recommends advanced courses in these technical competencies under specialized training and introductory courses in institutional topics. However, it is assumed that most private sector Project Managers will have this technical expertise as part of their background.
- Public sector Project Managers are expected to have a more well-developed institutional expertise, including a comprehensive view of ITS deployment to coordinate with other ITS activities. As such, the public sector Project Manager curriculum recommends advanced courses in these institutional competencies under specialized training with introductory courses in the technical competencies. However, it is assumed that most public sector Project Managers will contain this institutional expertise as part of their background.
- Private sector Project Managers must ensure that they and their staff have an understanding of transportation fundamentals, such as vocabulary, traffic/transport engineering basics, and analysis of flow and capacity. They must be able to understand and meet contracted goals and objectives, and understand the statutory limitations of using public funds. Frequently, the private sector’s lack of transportation experience creates a communications problem with public sector Project Managers, as does the public sector’s lack of experience with information technologies, systems engineering, and software development.
- A contracted project manager is expected to have a solid level of commitment to the project to ensure that turnover does not hamper the deployment schedule, delivery milestones, or communications with the public sector client.

The following competencies are recommended to build the breadth and depth required for ITS Project Managers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness System Integration (1) Systems Analysis and Design (4) ITS Planning (8) Data Analysis and Management (10) National ITS Architecture ITS Standards Software Development Software and Hardware Operations ITS Human Factors ITS Legal Issues Marketing /Public Relations	Organizational/Institutional Change (2) Technology Options (3) Managing Contractors (5) Financing (6) Writing/Communications (7) Identifying Stakeholders/Building Coalitions (9) Project Management Procurement Project Evaluation Transportation Fundamentals Partnerships Legislative and Policy Change Problem Solving Operations

Recommended Core Training and Education for Public Sector State DOT and City/County DOT ITS Project Managers

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/)	Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)		✓ Standards Training Modules (U.S. DOT)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)		✓ Advanced Transportation Management Technology Workshop (FHWA)
	✓ Deploying Integrated ITS — Rural (NHI)		✓ Managing Systems Integrators (ITSA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)		✓ ITS Software Acquisition (NHI)
	✓ ITS and the Transportation Planning Process (NHI)		✓ ITS Telecommunications Analysis (NHI)
	✓ ITS Public/Private Partnerships (NHI)		✓ Shared Resources for Telecommunications (NHI)
	✓ ITS Telecommunications Overview (NHI)		✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)		ITS Topic Specific:
	* Introductory courses on the software development process (U.S. DOT, vendors and universities)		✓ Freeway Management Systems (NHI)
	* Introductory courses on software integration (vendors and universities)		✓ Incident and Emergency Management Systems (NHI)
	* Introductory courses on systems engineering, installing and integrating hardware and software (vendors, universities, technical/vocational schools)		◇ Advanced Traveler Information Systems
	* Introductory courses on data analysis, management and databases (U.S. DOT, universities)		✓ Advanced Signal Control Systems (NHI)
	* Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)		◇ Electronic Toll Collection Systems
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)		◇ Highway-Rail Crossings
	* Course in marketing/public relations basics (universities, junior colleges)		Advanced Technology Options:
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)		✓ Freeway Traffic Operations (NHI)
	✓ Recommended reading in ITS and Human Factors (JPO)		✓ Traffic Control Software and Signalization (NHI)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.		✓ Computerized Traffic Signal Systems (NHI)
	◇ Workshop on using and writing ITS contracts and ITS specifications		✓ Advanced Traffic Signal Controllers (NHI)
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.		✓ HOV Facilities (NHI)
			✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT)
			◇ Other models as they become available
			* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
			* Advanced course in negotiations (U.S. DOT, universities, professional associations)
			* Advanced course in procurement and legal issues (U.S. DOT)
			◇ Seminar in ITS Legal Issues
			* Course in project management and change management (business schools, universities, professional associations)
			✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)

Recommended Core Training and Education for Public Sector Transit ITS Project Managers

Awareness Training	✓ ITS FTA in Transit (FTA)
	✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Telecommunications Overview (NHI)
	✓ Lessons Learned in ITS Procurement (NHI)
	* Introductory courses on the software development process (U.S. DOT, vendors and universities)
	* Introductory courses on software integration (vendors and universities)
	* Introductory courses on systems engineering, installing and integrating hardware and software (vendors, universities, technical/vocational schools)
	* Introductory courses on data analysis, management and databases (U.S. DOT, universities)
	* Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS and Institutional and Legal Issues (EDL)
	✓ Recommended reading in ITS and Human Factors (JPO)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.
	◇ Workshop on using and writing ITS contracts and ITS specifications.
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Transit Management Course (FTA)
	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ Standards Training Modules (U.S. DOT)
	✓ Procuring New Technologies for Transit NTI)
	✓ Managing Systems Integrators (ITSA)
	✓ ITS Software Acquisition (NHI)
	✓ ITS Telecommunications Analysis (NHI)
	✓ Shared Resources for Telecommunications (NHI)
	✓ Planning the Integration of Transit and Traffic ITS
	✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI)
	✓ Transit Performance Evaluation: Using Information -Based Strategies (NTI)
	✓ Reinventing Transit: Planning Information -Based Transit Services (NTI)
	ITS Topic Specific: ✓ Advanced Public Transportation Systems (FTA, NTI) ◇ Electronic Fare Payment Systems ◇ Advanced Traveler Information Systems
	◇ Use of planning models as they become available
	Advanced Technology Options: ✓ NTI Workshops on Advanced Technologies and Innovative Practices for Transit (NTI) ✓ Geographic Information Systems: Transit Applications (NTI) Geographic Information Systems: Transit Applications (NTI)
	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in procurement and legal issues (U.S. DOT)
	◇ Seminar in ITS Legal Issues
	* Course in project management and change management (business schools, universities, professional associations)
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)

Recommended Core Training and Education for Private Sector ITS Project Managers

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ITS in Transit (FTA) 	Specialized Training	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA) 		<ul style="list-style-type: none"> ✓ Standards Training Modules (U.S. DOT)
	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI) 		<ul style="list-style-type: none"> ✓ ITS Software Acquisition (NHI)
	<ul style="list-style-type: none"> ✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE) 		<ul style="list-style-type: none"> ✓ ITS Telecommunications Analysis (NHI)
	<ul style="list-style-type: none"> ✓ ITS and the Transportation Planning Process (NHI) 		<ul style="list-style-type: none"> ✓ Shared Resources for Telecommunications (NHI)
	<ul style="list-style-type: none"> ✓ ITS Public/Private Partnerships (NHI) 		ITS Topic Specific: Depends on project type
	<ul style="list-style-type: none"> ✓ ITS Telecommunications Overview (NHI) 		Advanced Technology Options: Depends on project type
	<ul style="list-style-type: none"> * Courses on project management (U.S. DOT, universities and junior colleges) 		<ul style="list-style-type: none"> * Advanced course in negotiations (U.S. DOT, universities, professional associations)
	<ul style="list-style-type: none"> * Course in marketing/public relations basics (universities, junior colleges) 		<ul style="list-style-type: none"> * Advanced course in procurement and legal issues (U.S. DOT)
	<ul style="list-style-type: none"> ✓ Recommended reading in ITS Institutional and Legal Issues (EDL) 		<ul style="list-style-type: none"> * Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	<ul style="list-style-type: none"> ✓ Recommended reading in ITS and Human Factors 		<ul style="list-style-type: none"> ✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT) ◇ Other planning models as they become available
	<ul style="list-style-type: none"> ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment 		<ul style="list-style-type: none"> * Courses on the software development process (U.S. DOT, vendors and universities)
			<ul style="list-style-type: none"> * Advanced courses on software integration (vendors and universities)
			<ul style="list-style-type: none"> * Advanced courses on systems engineering, installing and integrating hardware and software (vendors, universities, technical/

ITS Curriculum — Software Developers

Role Description: The role of Software Developer within ITS deployment is emerging as one of the more critical ones since most ITS is dependent upon software for a wide variety of functions.

Some agencies will employ software developers to develop proprietary programs. Frequently, however, software development is not perceived to be a core competency in a public sector agency. On bigger and more complex projects, the agencies contract with a consultant or vendor who offers a mix of services, including software development.

Typical backgrounds of software developers are in computers and software engineering. It is critical for the software developer to have a good understanding of transportation fundamentals and mode-specific applications in order to develop software that is relevant to the agency. For instance, signal timing requires more than just LAN/WAN connections; it requires understanding how to time an intersection and the compounded effects of timed intersections on each other in terms of traffic flow. Again, the ability to work closely with the client aids in this understanding. They must also have in-depth knowledge of system analysis and design, the various technologies that will comprise the system, software and hardware operations, systems integration process and schedule, and data flow, analysis, and management issues.

Functions and Responsibilities:

- Understand and design software to meet the needs of the system characteristics, such as existing compatibility, expandability, and maintenance issues.
- Understand and design software to meet the needs of end users.
- Write or adapt off-the-shelf/existing software to collect transportation system information for decision-making in real-time.
- Manage the software development process to meet the contract agency's milestones.
- Communicate frequently with public-sector project manager regarding the development process, schedule, software's abilities, and compatibility issues with hardware, other software, and other systems.
- Work with systems designers to adapt software to meet the needs of the whole system.
- Participate in defining performance measures for acceptance testing of software and system.

The following is a list of the recommended competencies to build the depth required for Software Developers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Writing/Communications (7) Project Management ITS Legal Issues Project Evaluation Operations Transportation Fundamentals	Systems Integration (1) System Analysis and Design (4) Database Management and Analysis (10) National ITS Architecture ITS Standards ITS Human Factors Software Development Software and Hardware Operations Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Software Developers

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ITS in Transit (FTA)	Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT) or
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)		✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)		✓ Standards Training Modules (U.S. DOT)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)		✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Deploying Integrated ITS — Rural (NHI)		✓ ITS Telecommunications Analysis (NHI)
	✓ ITS Telecommunications Overview (NHI)		Technology Options:
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)		✓ Advanced Transportation Management Technology Workshop (FHWA) or
	* Course in procurement and legal issues (U.S. DOT)		✓ Procuring New Technologies for Transit (NTI) and Geographic Information Systems: Transit Applications (NTI)
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)		* Advanced courses on software integration and performance testing (vendors and universities)
	* Courses on project management (U.S. DOT, universities and junior colleges)		* Courses on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical schools)
	✓ Recommended reading in ITS Institutional and Legal Issues		* Advanced courses on data analysis, management and databases (universities)
	✓ Recommended reading in ITS and Human Factors (JPO)		* Courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefits analysis after deployment.		
	✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)		

ITS Curriculum — System Designers and Integrators

Role Description: Systems Designers and Integrators perform critical roles in ITS deployment. These roles require a broad technical understanding of ITS to be able to envision and connect hardware and technologies together and apply software applications to form working systems. It also means being able to integrate older “legacy” systems into operations. These roles also require a specific knowledge of how to design, install, integrate, operate, and test the technologies and systems being deployed. Knowledge of the fundamental principles of different types of engineering sciences is essential to these roles including:

- Electrical engineering;
- Telecommunications engineering;
- Systems engineering including systems architecture and standards;
- Software development including how software integrates with various ITS technologies;
- Hardware and wiring requirements;
- Relational databases and data sharing/data flow requirements.

Systems designers and integrators play complementary but different roles in ITS. Whereas one envisions and puts on paper the system to come, the other does hands-on application to make it happen. However, the competency set required is similar.

Functions and Responsibilities:

- Analyze existing infrastructure.
- Conduct user needs assessment; map out data flows to users.
- Design a system; ensure compatibility with existing infrastructure.
- Analyze technology options and participate in the decision making for the various devices, computers, and software applications; provide designs for and connect devices through telecommunication wiring or wireless media.
- Install ITS technologies, ensuring functionality and quality control; bring together components to function as one system.
- Integrate technologies into existing system.
- Participate in the design of performance measures; participate in the testing and evaluation throughout project and at end (part of the testing is ensuring that the right data is flowing in the right direction without corruption).
- Train operators, maintenance and support staff on system functions, operations, maintenance and management.; ensure maintenance procedures and operations manuals are available.

Systems designers and integrators are predominantly employed in the private sector, although some professionals are employed by public sector transportation agencies. The competencies are similar, with the caveat that private sector designers and integrators must have a background in basic transportation fundamentals in order to understand why the transportation agency wants the system to function as it does, and to ensure that the system delivers the functions needed. The following is a list of the recommended competencies to build the breadth and depth required for Systems Designers and Integrators:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Writing/Communications (7) ITS Legal Issues Project Management Procurement Operations, especially agency procedures Transportation Fundamentals	Systems Integration (1) Organizational/Institutional Change (2) Technology Options (3) System Analysis and Design (4) Data Analysis and Management (10) National ITS Architecture ITS Standards Software Development ITS Human Factors Software and Hardware Operations Problem Solving Project Evaluation

Recommended Core Training and Education for Systems Designers and Integrators

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA) 	Specialized Training	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT) or ✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) 		<ul style="list-style-type: none"> ✓ Standards Training Modules (U.S. DOT)
	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI) 		Advanced Technology Options: Depends on the type of ITS project
	<ul style="list-style-type: none"> ✓ ITS Telecommunications Overview (NHI) 		<ul style="list-style-type: none"> ✓ ITS Telecommunications Analysis (NHI)
	<ul style="list-style-type: none"> ✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT) 		<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	<ul style="list-style-type: none"> Technology Options: <ul style="list-style-type: none"> ✓ Advanced Transportation Management Technology Workshop (FHWA) or ✓ Procuring New Technologies for Transit (NTI) 		<ul style="list-style-type: none"> ✓ Lessons Learned in ITS Procurement (NHI)
	<ul style="list-style-type: none"> * Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations) 		ITS Topic Specific: Depends on project type
	<ul style="list-style-type: none"> * Courses on project management (U.S. DOT, universities and junior colleges) 		<ul style="list-style-type: none"> * Advanced courses on the software development process (U.S. DOT, vendors and universities)
	<ul style="list-style-type: none"> * Course in procurement and legal issues (U.S. DOT) 		<ul style="list-style-type: none"> * Advanced courses on software integration and performance testing (vendors and universities)
	<ul style="list-style-type: none"> * Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations) 		<ul style="list-style-type: none"> * Advanced courses on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools)
	<ul style="list-style-type: none"> ✓ Recommended reading in ITS Institutional and Legal Issues (EDL) 		<ul style="list-style-type: none"> * Advanced courses on data analysis, management and databases (universities)
	<ul style="list-style-type: none"> ✓ Recommended reading in ITS and Human Factors (EDL) 		<ul style="list-style-type: none"> * Advanced courses on operating and maintaining networks and software, and inspections and testing of systems (vendors, technical/vocational schools)
	<ul style="list-style-type: none"> ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment 		<ul style="list-style-type: none"> * Advanced courses on software and human factors (universities)
	<ul style="list-style-type: none"> ◇ Workshop on using and writing ITS specifications 		<ul style="list-style-type: none"> ✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)
			<ul style="list-style-type: none"> * Course in project management and change management (business schools, universities)

ITS Curriculum — Operators

Role Description: Successful implementation of an ITS project results in more efficient operations of the existing transportation system. Operators are at the heart of the system, working at Transportation Management Centers at State and City/County DOTs or at Transit Operations Centers or Traveler Information Centers. They used to be predominantly public sector employees, but the recent wave of privatization has brought private sector firms in to manage these centers.

The role of the **operator within a management/operations center** is to ensure the smooth operation of the system, identify problems, and initiate and follow-through with responses. Operators use computers and video to monitor capacity and flow, collect data and make decisions in real-time for better management of the transportation system.

Traveler information center operators play a more limited role in delivering system information to the public. They respond to traveler's phone inquiries and maintain internet site and kiosk information. They manage the advanced traveler information systems which may include applications for cell phones, kiosks, variable message signs, the internet, etc.

Recent deployment experiences have revealed that operators should be included in the systems analysis and design process. Designers must consider what information they need, how the information is used, and how the operator is physically set-up to function in his/her space.

Operators require knowledge of basic transportation fundamentals and terminology, with extensive knowledge of the local transportation network and incident and emergency management procedures especially hazardous material diagnostics. These individuals must have good communication and problem-solving skills, and must be able to react quickly and rationally to an incident. Multi-tasking capabilities are also important for anyone performing one of these roles. Presentation skills are particularly important when interacting with the media.

Functions and Responsibilities:

- Monitor system capacity and flow.
- Help to make real-time decisions and communicate those to the public.
- Help to diagnose incidents and provide coordinated quick-response to traffic and incident problems by dispatching appropriate assistance.
- Broadcast status information; possibly interact with media.
- Be well-versed in agency policies and procedures for disseminating information
- Be able to utilize ITS technologies such as variable message signs for broadcast to and management of the traveling public.
- Identify and report/repair minor communications/computing system problems.
- Understand the system well enough technically to troubleshoot minor problems with hardware/equipment functionality.
- Be able to clearly communicate with the information system support professionals (I/S or MIS or System Maintenance and Support Technicians) about minor and major problems.
- For transit and traveler information operators, provide automated trip planning services; determine call needs; offer suggestions for travel options.

The following is a list of the recommended competencies to build the breadth and depth required for Operators:

ITS Curriculum — Operators (cont'd)

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) Technology Options (3) Data Analysis and Management (10) Marketing/Public Relations Systems Support and Maintenance Operations, especially agency procedures	Writing/Communications (7) Software and Hardware Operations Transportation Fundamentals ITS Topics: <ul style="list-style-type: none"> • Incident and Emergency Management Systems • Hazardous Materials • Freeway Management Systems • Advanced Public Transportation Systems Problem Solving

Recommended Core Training and Education for Operators

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	Technology Options: Depends on the type of ITS project
	* Introductory courses on data analysis, management and databases (U.S. DOT, universities)

Specialized Training	* Course in the basics of public relations and public speaking (universities, junior colleges)
	* Courses on operating and minor troubleshooting of networks, hardware, and software (vendors, technical/vocational schools)
	* Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	* Advanced courses/certification in transportation operations (universities – e.g., CalPoly course, technical/vocational schools)
	ITS Topic Specific: Depends on type of management/operations/information center

ITS Curriculum — Dispatchers

Role Description: Dispatchers work closely with operators to manage fleets of vehicles that are critical in responding to: incidents, demand, or other problems. Dispatchers are predominantly public sector employees and are a mix of traditional and non-traditional transportation agency staff who work on-site at management/operations centers as:

- Transit agency employees to dispatch buses.
- State and City/County DOT agency employees to dispatch tow trucks, snow plows, and other vehicles.
- Public safety employees to dispatch police, fire and emergency vehicles.
- Contractors hired as part of the operations staff at highway, traffic or transit agencies.

Dispatchers know where their vehicles are through vehicle location devices that are part of the system. Dispatchers help operators make decisions about the use of a vehicle and driver in mitigating a transportation system problem, such as an incident or increase in demand. They then make decisions as to how to get the vehicle in use or to a particular destination as quickly and safely as possible. Typically, dispatchers have risen through the ranks of highway and city patrol officers and others who have "road experience" and are familiar with the transportation network.

More so than operators, dispatchers are frequently engaged in cross-agency cooperation and team work. They must have an overall sense of the goal of operations, and be clear on the various agency operations procedures, and the potential jurisdictional issues and legal issues that might arise.

Functions and Responsibilities:

- Manage location devices to track fleet.
- Dispatch and scheduling procedures.
- Determine caller needs.
- Provide coordinated quick-response to traffic and incident problems by dispatching appropriate assistance.
- Identify and report/repair system problems.

The following is a list of the recommended competencies to build the breadth and depth required for Dispatchers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) and/or agency procedures Technology Options (3) Data Analysis and Management (10) ITS Legal Issues Operations	Transportation Fundamentals Software and Hardware Operations Problem Solving ITS Specific Topics: <ul style="list-style-type: none">• Incident Management• Hazardous Materials• Diagnostics and Procedures• Vehicle Diagnostics

Recommended Core Training and Education for Dispatchers

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	Technology Options: Depends on the type of ITS project
	<ul style="list-style-type: none"> * Courses on data analysis, management and databases (U.S. DOT, universities)
	<ul style="list-style-type: none"> ◇ Seminar on ITS Legal Issues

Specialized Training	<ul style="list-style-type: none"> * Courses on operating and minor troubleshooting of networks, hardware, and software (vendors, technical/vocational schools)
	<ul style="list-style-type: none"> * Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	<ul style="list-style-type: none"> * Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	<ul style="list-style-type: none"> * Advanced courses/certification in transportation operations (universities – e.g., the TMC Operators course at the California Polytechnic Institute, technical/vocational schools)
	<p>ITS Topic Specific: Depends on type of management/operations/information center but should include:</p> <ul style="list-style-type: none"> ✓ Incident Management (NHI) ◇ Hazardous Materials ◇ Vehicle Diagnostics and Procedures

ITS Curriculum — Drivers

Role Description: “Drivers” include tow truck operators, law enforcement, emergency personnel, and transit drivers, among others. Drivers work closely with operators and dispatchers to respond to requests for assistance in emergencies or for increased demand. They are human probes on the roadway and report information and observations back to the management/operations center to supplement the data from the devices. They are also recipients of fully synthesized information from the center. Thus they must have good verbal communication skills. They also must be trained on the devices located on their vehicles for proper operations, downloading data, understanding how their data affects the system’s management, and how the devices support them doing their job.

Functions and Responsibilities:

- Report information and observations back to the management/operations center to supplement the data from the vehicle devices or the system network.
- Respond to dispatcher requests.
- Follow agency/company procedures in incident and emergency management.
- Download data at shift’s end.

The following is a list of the recommended competencies to build the breadth and depth required for Drivers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Transportation Fundamentals Data Analysis and Management (10) Operations	Technology Options (3) , especially training on ITS devices ITS Topics: <ul style="list-style-type: none">• Incident and Emergency Management• Hazardous Materials Management

Recommended Core Training and Education for Drivers

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	<ul style="list-style-type: none"> * Courses on data analysis, management and databases (U.S. DOT, universities)
	<ul style="list-style-type: none"> * Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)

Specialized Training	<ul style="list-style-type: none"> * Training on ITS devices on vehicles (vendors)
	<p>ITS Topic Specific: Depends on type of management/operations/information center but should include:</p> <ul style="list-style-type: none"> ✓ Incident and Emergency Management (NHI) ◇ Hazardous Materials Management ◇ Vehicle Diagnostics

ITS Curriculum — Electronics Inspection and Maintenance Technicians

Role Description: Electronics inspection and maintenance technicians have traditionally maintained the electronics installed by contractors at the agency and in the field. Typically, contractors have trained public sector electronics technicians on the operation and the maintenance of the devices. Technicians are responsible for replacing and repairing devices that do not work and performing preventive maintenance on the technologies. With the advent of ITS, these individuals must be a greater part of the system design effort to ensure smooth integration of the ITS project into existing maintenance activities. This includes an involvement in the upfront stages of ITS planning, design and procurement where these technicians can provide important insight into:

- The technology selection process to ensure compatibility with existing devices and to plan for the inventory impact.
- Physical placement of the devices on the infrastructure to ensure ease of access, cost effective procedures of installation, and safety when making future repairs or expansions.
- The human factors of placing the equipment within the cabinets to ensure safety.

Functions and Responsibilities:

- Test and inspect construction and integration work, especially fiber optic splices and connections.
- Work with systems designers on technology selection and physical placement.
- Evaluate project operations.
- Troubleshoot problems in the field, including repairing and replacing ITS technologies (electronic devices) and hardware.
- Troubleshoot hardware and software problems.
- Install new equipment and integrate with existing systems.
- Supervise and inspect contractor installations.
- Maintain and repair traffic signal control systems.
- Work with systems designers to establish a proper cabinet and equipment placement on the infrastructure, as the human factors and safety considerations are particularly important for future repair and expansion.

The following competencies are recommended to build the ITS understanding required for electronics inspection and maintenance technicians:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Organizational/Institutional Change (2) Systems Analysis and Design (4) Managing Contractors (5) Writing/Communications (7) National ITS Architecture ITS Standards ITS Human Factors Project Evaluation Transportation Fundamentals	Technology Options (3) Software and Hardware Options Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Electronics Inspection and Maintenance Technicians

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT)
	✓ Lessons Learned in ITS Procurement (NHI)
	* Courses on software integration (vendors and universities)
	* Introductory courses on systems engineering, installing and integrating hardware and software, telecommunications engineering, electrical engineering (vendors, universities, technical/vocational schools)
	* Introductory course in verbal and written communications, presentations (universities, junior colleges)
	✓ Recommended reading in ITS and Human Factors (EDL)
	◇ Seminar on ITS Legal Issues
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment
	◇ Workshop on using and writing ITS specifications
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)

Specialized Training	✓ Managing Systems Integrators (ITSA)
	✓ Standards Training Modules (U.S. DOT)
	Advanced Technology Options: Depends on the type of ITS project
	Advanced Technology Options: Depends on project type
	* Advanced courses on networks (vendors, universities, technical/vocational schools)
	* Advanced courses on repairing and maintaining electronics (vendors, universities, technical/vocational schools)

ITS Curriculum — Operations Managers/Supervisors

Role Description: The Operations Manager/Supervisor is responsible for running an operations center, referred to as Transportation Management Centers (TMCs) or Operations Centers (TOCs) depending on agency terminology. He/she determines operating procedures regarding signal controls and VMS message broadcasting based on congestion and incident data. This requires establishing decision-making procedures in cooperation with police, emergency staff, and other agency dispatchers. In the transit industry, this person actually manages the operation. For instance, the day-to-day transportation functions of a bus system are their responsibility.

These individuals must be adept at managing a rotating staff. They must have a strong understanding of the mission and the operational protocols of the TMC. In addition, they must be knowledgeable about the software, hardware, and operating systems, and experienced at troubleshooting technical problems and with incident management protocols. Most people at this level have come up through the ranks. They possess an in-depth knowledge of the existing system and its complexities and a strong transportation engineering background. Some of the interviewees had a traffic broadcasting background. Computer skills varied by agency.

Operations Managers/Supervisors step in as deployment activities turn to actual operations activities. They work closely with Project Managers to ensure that the system they inherit performs as needed, and continue to work with systems integrators and maintenance technicians to resolve operational needs.

Functions and Responsibilities:

- Managers:
 - Responsible for TMC Operations
 - Determine operating procedures including signals and VMS messages based on congestion and incident data.
 - Establish decision making procedures in cooperation with police, emergency staff, and other agency dispatchers.
 - Responsible for staffing; writing job descriptions; hiring and training in-house and contracted staff; negotiating staff conflicts.
 - Responsible for TMC budget development and monitoring.
 - Interacts with media on both marketing and incident reporting to the general public.
- Supervisors:
 - Manage staff and schedule shifts.
 - Provide on-the-job staff training.
 - Resolve day-to-day staff and equipment problems.

The following is a list of the recommended competencies to build the depth and breadth required for Operations Managers and Supervisors:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Data Analysis and Management (10) ITS Standards Partnerships Marketing/Public Relations Project Management Project Evaluation ITS Human Factors	Organizational/Institutional Change (2) Technology Options (3) , especially training on ITS devices Managing Contractors (5) Financing (6) , especially budgeting and accounting procedures Software and Hardware Operations Systems Support and Maintenance Problem Solving Operations

Recommended Core Training and Education for Operations Managers and Supervisors

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	<ul style="list-style-type: none"> ✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	<ul style="list-style-type: none"> ✓ ITS and the Transportation Planning Process (NHI)
	<ul style="list-style-type: none"> ✓ ITS Public/Private Partnerships (NHI)
	If Transit Operations Manager: <ul style="list-style-type: none"> ✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI) ✓ Reinventing Transit: Planning Information - Based Transit Services (NTI)
	<ul style="list-style-type: none"> * Courses on project management (U.S. DOT, universities and junior colleges)
	<ul style="list-style-type: none"> * Course in public relations and public speaking (universities, junior colleges)
	<ul style="list-style-type: none"> * Courses on data analysis, management and databases (U.S. DOT, universities)
	<ul style="list-style-type: none"> ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment
	<ul style="list-style-type: none"> * Recommended reading on ITS and Human Factors (JPO)

Specialized Training	Technology Options: <ul style="list-style-type: none"> ✓ Advanced Transportation Management Technology Workshop (FHWA) or ✓ Procuring New Technologies for Transit (NTI)
	Advanced Technology Options: Depends on project type
	If Transit Operations Manager: <ul style="list-style-type: none"> ✓ NTI Workshops on Advanced Technologies and Innovative Practices for Transit (NTI) and ✓ Geographic Information Systems: Transit Applications (NTI)
	<ul style="list-style-type: none"> ✓ Managing Systems Integrators (ITSA)
	<ul style="list-style-type: none"> * Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	<ul style="list-style-type: none"> * Course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	<ul style="list-style-type: none"> * Courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	<ul style="list-style-type: none"> * Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	<ul style="list-style-type: none"> * Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	<ul style="list-style-type: none"> * Course in change management (business schools, universities, professional associations)

ITS Curriculum — Business Analyst

Role Description: The position of Business Analyst is becoming increasingly important in ITS for numerous reasons. First, given the high costs of technology deployments, solid investment analysis must be done to “market” ITS projects to high-level decision-makers. In addition, innovative financing methods are increasingly being used. Partnership agreements require analysis of financial and investment risk. Decisions on technologies require cost/benefit analysis. Interviewees stressed the growing need to have this role filled within agencies and on projects.

Functions and Responsibilities:

- Provide suggestions for making project and investment decisions.
- Perform cost/benefit and other related analyses on technologies and systems.
- Suggest organizational changes for project deployment.
- Help in forming financial partnerships for projects such as smart card partnerships.
- Supply input on project evaluation.

The following is a list of the recommended competencies to build the depth and breadth required for Business Analysts:

Awareness Level Competency Recommendations	Specialized Level Competency Recommendations
ITS Awareness Technology Options (3) Writing/Communications (7) Data Analysis and Management (10) ITS Legal Issues Legislative and Policy Change Procurement Software and Hardware Operations Transportation Fundamentals	Organizational/Institutional Change (2) Financing (6) Partnerships Project Evaluation

Recommended Core Training and Education for Business Analysts

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	Technology Options: Depends on the type of ITS project
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	◇ Workshop on using and writing ITS contracts and ITS specifications
	* Courses on data analysis, management and databases (U.S. DOT, universities)
	◇ Seminar on ITS Legal Issues
	✓ Lessons Learned in ITS Procurement (NHI)
	* Course in procurement and legal issues (U.S. DOT) ✓ Procuring New Technologies for Transit (NTI)
	* Courses on software applications such as word processing, spreadsheets, databases or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	◇ Case studies from agencies who worked with their state, regional and local legislators and appointed officials to change policies to incorporate ITS
	* Course in change management (business schools, universities, professional associations)

Specialized Training	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	* Advanced courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	✓ Shared Resources for Telecommunications (NHI)
	✓ ITS Software Acquisition (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	◇ Workshop on ITS project evaluation, setting performance measures, and cost/benefit analysis after deployment
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)

ITS Curriculum — Data(base) Manager/Analyst

Role Description: Data(base) Managers/Analysts play a critical role in ITS operations and management given the breadth of data generated from advanced technologies. The proliferation of data collection devices, the need for public agencies to continually deliver “more for less”, and the advances in database technology create a situation where so much information is available that it can tend to be overwhelming. The essence of any ITS device is the data that it produces, and the value of the system is closely related to how the data is used. Agencies need to apply the information they have gathered in ways that will improve their transportation systems, and better inform their decision-making processes. This is where the role of Data Managers and Analysts becomes critical.

Functions and Responsibilities:

- Help define data standards to enable cross agency data sharing; help define and support data sharing across agencies.
- Design, maintain and manage relational databases for decision making.
- Turn raw data into usable information.
- Design report formats and run queries (SQL) and reports; perform analysis as requested, generate useful and timely reports, coordinate data sharing with other agencies and monitor data security and storage.
- Analyze data for patterns and trends; interpret data and use it for problem solving and decisionmaking.
- Report and disseminate data throughout organization; disseminate data results to other agencies.
- Responsible for overall quality and integrity of data generated and used by the system.
- Keep project management well-informed of potential uses of data for planning, project evaluation and other purposes.
- Assist with studies: for example in highway agencies, speed and volume studies; in transit agencies, performance reports that support the scheduling, fleet management, and service planning staff functions.
- Ensure databases comply with standard communications protocols and ITS standards.

The following is a list of the recommended competencies to build the depth and breadth required for Data(base) Managers and Analysts:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) Technology Options (3) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) National ITS Architecture ITS Standards ITS Human Factors, especially human interface design Transportation Fundamentals Operations	Systems Integration (1) Systems Analysis and Design (4) Data Analysis and Management (10) Software Development Software and Hardware Operations Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Data(base) Managers and Analysts

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ ITS Telecommunications Overview (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	✓ ITS and the Transportation Planning Process (NHI)
	If a Transit Manager: ✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI) and ✓ Reinventing Transit: Planning Information - Based Transit Services (NTI) and ✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)
	✓ Use of the CORSIM Computer Traffic Simulation Model (NHI) ◇ Other models as they become available
	* Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	✓ Recommended reading on ITS and Human Factors (JPO)
	* Introductory course on software and human factors

Specialized Training	✓ Using the National ITS Architecture for Deployment—Public Sector (U.S. DOT)
	✓ Standards Training Modules (U.S. DOT)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ ITS Telecommunications Analysis (NHI)
	* Introductory course on the software development process (U.S. DOT, vendors and universities)
	* Course on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools)
	* Advanced courses on data analysis management and databases (universities)
	* Advanced courses on software applications such as basic language, databases, relational databases, queries and reports, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)

ITS Curriculum — Contract Specialists

Role Description: Like traditional transportation capital improvement projects, ITS requires the use of contracts to procure necessary equipment and services. However, ITS equipment and services have proven to be unique to many procurement divisions in transportation agencies. Therefore, ITS contracts require different clauses and procurement methods. It also requires the ability and flexibility to contract for expertise that tends not to have a discrete time period or deliverable date.

Contract Specialists in ITS are those professionals who recognize all of these nuances, and know the agency's and state's legislative limitations well enough to figure out how to procure what they need for their ITS deployment. The contract specialist role is typically performed as part of the project manager's role, working in conjunction with their agency legal staff or, in some cases, even their state's attorney generals. However, there are agencies who employ acquisitions staff who will need to develop these competencies in order to provide effective contracts for ITS project contractors and technology purchases.

Functions and Responsibilities:

- Help prepare contracts.
- Incorporate clauses in contracts to address ITS issues including software ownership and Intellectual Property Rights.
- Select the most appropriate contract type for deployment.
- Help shape contract language based on the RFP and the negotiated agreement; help ensure that the final contract reflects the planned scope of work, not simply the RFP wording.
- Help ensure that value-added services are reflected in contracts, if appropriate, e.g., vendor training on purchased equipment, ongoing maintenance, provision of operations and maintenance procedures manuals, etc.

The following is a list of the recommended competencies to build the depth and breadth required for Contract Specialists:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Financing (6) Partnerships Legislative and Policy Change Software Development Software and Hardware Operations	Writing/Communications (7) Procurement ITS Legal Issues

Recommended Core Training and Education for Contract Specialists

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Telecommunications Overview (NHI)
	* Courses in public sector financial management: Cost/benefit analysis, Risk analysis, Investment analysis, Budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Introductory course on the software development process, software integration into a system, and performance measures for testing (U.S. DOT, vendors, universities)
	* Introductory course on operating and maintaining networks and software (vendors, technical/vocational schools)
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	* ITS America's Legislative Affairs web site: http://www.itsa.org/legislative.html

Specialized Training	✓ Lessons Learned in ITS Procurement (NHI)
	✓ ITS Software Acquisition (NHI)
	✓ Shared Resources for Telecommunications (NHI) (as needed — depending on the type of project)
	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course in procurement and legal issues (U.S. DOT)
	◇ Advanced workshop course in writing contracts for ITS procurements
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)

ITS Curriculum — Legal Staff

Role Description: Agency legal staffs are primarily involved in the preparation, review and execution of contracts, as well as an assessment of the project's risks and liabilities. Their up-front, as well as on-going involvement in understanding the project manager's role, and in the process of writing the RFPs and contracts for ITS can prove very valuable. Legal staff are responsible for helping project managers and agency executives understand the limits of the state's laws for using contracts as well as in approaching the state legislature for changes in law and policy. When legal staff were not aware of ITS issues, their review of the related contracts delayed the deployment process and they became obstacles to deployment.

Another role for legal staff in ITS is for negotiating such new situations as telecommunications leases or shared resource agreements. Their analysis of the potential liability that could arise from ITS deployments, and their assessment of the risk that it poses to the transportation agency can be invaluable, for instance, law suits that arise from providing route guidance in the instance of an accident or, privacy issues that arise from video enforcement.

Their expertise in the legal issues can come from involvement in an ITS deployment, learning from ITS America's legal issues committee, or even taking a class in specific areas that ITS introduces, such as software development law or intellectual property rights law. Their law degree gives them the foundation to understand state laws and agency authority limitations, as well as for understanding contracting and the various types available.

Functions and Responsibilities:

- Review project specifications for liability issues in design.
- Review contracts for clauses and language supportive of ITS.

The following is a list of the recommended competencies to build the depth and breadth required for Legal Staff:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Financing (6) Software Development Transportation Fundamentals	Writing/Communications (7) ITS Legal Issues Legislative and Policy Change Partnerships Procurement

Recommended Core Training and Education for Legal Staff

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA) 	Specialized Training	<ul style="list-style-type: none"> ✓ Lessons Learned in ITS Procurement (NHI)
	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI) 		<ul style="list-style-type: none"> ✓ ITS Software Acquisition (NHI)
	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA) 		<ul style="list-style-type: none"> ✓ ITS Public/Private Partnerships (NHI)
	<ul style="list-style-type: none"> ✓ ITS Telecommunications Overview (NHI) 		<ul style="list-style-type: none"> ✓ Shared Resources for Telecommunications (NHI)
	<ul style="list-style-type: none"> ✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE) 		<ul style="list-style-type: none"> * Course in procurement and legal issues (U.S. DOT)
	Technology Options: Depends on the type of ITS project		<ul style="list-style-type: none"> * Advanced course in writing business plans/ project plans, writing specifications, contracts (U.S. DOT, universities, professional associations)
	<ul style="list-style-type: none"> * Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges) 		<ul style="list-style-type: none"> ◇ Advanced workshop course in using and writing ITS contracts for ITS procurements
	<ul style="list-style-type: none"> * Courses on the software development process (U.S. DOT, vendors, universities) 		<ul style="list-style-type: none"> ◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	<ul style="list-style-type: none"> * Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations) 		<ul style="list-style-type: none"> * Course in change management (business schools, universities)

ITS Curriculum — Marketing/Public Relations Staff

Role Description: This role has become important given the need to publicize ITS to politicians, transportation officials and the general public. Marketing/Public Relations staff at public transportation agencies summarize ITS benefits and “lessons learned” in presentations targeted at high-level decision-makers, elected and appointed officials and the general public.

These individuals must have excellent communication skills. They must know how to communicate the benefits of ITS projects to high level decision-makers, elected and appointed officials, the general public and the press. This involves segmenting audiences and tailoring presentations to create "buy in". They can also be instrumental in promoting ITS internally, changing organizational behavior to a positive acceptance of ITS projects.

Functions and Responsibilities:

- Summarize ITS benefits and “lessons learned” in presentations targeted at high level decision makers and officials.
- Disseminate educational and promotional material to the public to enhance informed decision making by travelers.
- Segment, understand, and provide outreach to audiences that need to know about ITS.
- Inform travelers and other agencies about new ITS systems and their benefits; demonstrate benefits.

The following is a list of the recommended competencies to build the depth and breadth required for Marketing / Public Relations Staff:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) Technology Options (3) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Transportation Fundamentals National ITS Architecture	Writing/Communications (7) Marketing/Public Relations

Recommended Core Training and Education for Marketing / Public Relations Staff

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS

Specialized Training	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in presentations and negotiations (U.S. DOT, universities, professional associations)
	* Advanced courses in marketing and public relations (universities, junior colleges)
	✓ Recommended reading: Marketing ITS Infrastructure in the Public Interest (EDL)

ITS Curriculum — Human Resources Staff

Role Description: Human Resources staff works closely with project managers to staff ITS teams. These individuals must know how to write job descriptions or adapt existing ones to include technical skills and responsibilities. They must also have a good understanding of salary scales to hire and retain staff needed for an ITS project.

Human Resource staff will see job classifications, descriptions and staff hiring trends change with ITS deployments. They must therefore be included in ITS PCB efforts.

A typical background includes knowledge of agency rules and regulations related to job classifications, descriptions and salary requirements. Backgrounds can also include either formal education in human resource management or many years of experience. If training is involved, a background in teaching is required.

Functions and Responsibilities:

- Work with Project Managers to hire or develop ideal team.
- Facilitate new job descriptions.
- Provide training.
- Hire and train operators on automated system use.
- Promote the acceptance of required operating changes

The following is a list of the recommended competencies to build the depth and breadth required for Human Resources Staff:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Transportation Fundamentals Software and Hardware Operations Operations, especially agency procedures	Organizational/Institutional Change (2) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Marketing/Public Relations

Recommended Core Training and Education for Human Resources Staff

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ ITS Public/Private Partnerships (NHI)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	* Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Course in change management (business schools, universities)
	✓ Recommended reading in ITS Institutional Issues (EDL)

Specialized Training	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	* Course in marketing/public relations basics (universities, junior colleges)
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS

ITS Curriculum — Systems Administrators/Support Technicians

Role Description: Systems Administrators and Support Technicians maintain computer systems including servers, workstation clients, software, related hardware and un-interruptible power supply systems. They manage the networks — both technical (Computer Aided Dispatching, remote device control, and infrastructure monitoring) and administrative (user accounts, e-mail and system security). They plan, install, and maintain software, and provide upgrades. Typically this individual is a “jack of all trades” who ends up doing some programming, database or spreadsheet design, or scripting.

Given that ITS deployments can have extensive computer systems that collect, organize and disseminate information to different agency departments as well as other agencies, Systems Administrators and Support Technicians have added responsibilities in helping to manage the flow of data and help plan for its archiving, for which further professional capacity building may be needed.

Functions and Responsibilities:

- Work with systems designers to ensure technical and technological feasibility of design.
- Assist systems integrators and software developers with installation and testing, including the integration of software with the hardware systems.
- Assist with the evaluation of ITS deployments.
- Maintain data network and server, including data archiving and backups.
- Maintain and update hardware and software; troubleshoot systems hardware and software problems.
- Manage network; manage user accounts.
- In cooperation with electronic maintenance technicians, repair and replace ITS technologies.
- Follow maintenance procedures for prevention.

The following is a list of the recommended competencies to build the breadth and depth required for Systems Administrators and Support Technicians:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Technology Options (3) Systems Analysis and Design (4) Writing/Communications (7) Data Analysis and Management (10) Software Development ITS Legal Issues Project Evaluation Operations Transportation Fundamentals	Software and Hardware Operations Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Systems Administrators and Support Technicians

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	✓ ITS Telecommunications Overview (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	* Introductory courses on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools)
	* Introductory courses on software integration and performance testing (vendors and universities)
	* Course on data analysis, management and databases (universities)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	◇ Seminar on ITS Legal Issues

Specialized Training	If Transit Agency: ✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)
	* Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Advanced courses (and/or certifications) on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	* Advanced courses (and/or certifications) on repairing and maintaining electronics (vendors, technical/vocational schools, universities)

ITS Curriculum — Program/Agency Managers

Role Description: Program/Agency Managers are higher level agency decision makers. Whereas Project Managers are concerned with daily project activities throughout all the stages of deployment, Program/Agency Managers are concerned with how the ITS projects fit in with or impact other agency work, agency staffing and functioning, organizational and institutional changes, funding, and policy reform and legislative changes that facilitate smoother deployments.

This role is important especially in the mainstreaming of ITS into the transportation planning process. The Program/Agency Manager can ensure that an agency considers ITS as possible solutions to transportation problems and that projects are compliant with federal regulations. They can help to identify federal, state, local, and private sector funding sources and apply for them. They can ensure that all legal conformity requirements are met, for example, that the technologies are using accepted standards and are consistent with the National ITS Architecture. They may have to explore the possibility of promoting legislative, organizational, or policy change to facilitate ITS deployments.

Functions and Responsibilities:

- Provide outreach and education to senior decision makers and appointed and/or elected officials .
- Work to diminish agency and institutional barriers.
- Build coalitions among agencies and with the private sector.
- Form working groups and task forces.

The following is a list of the recommended competencies to build the ITS breadth and depth required for Program/Agency Managers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Systems Analysis and Design (4) ITS Planning (8) Data Analysis and Management (10) National ITS Architecture ITS Standards Procurement ITS Legal Issues Project Management Software and Hardware Operations Operations	Organizational/Institutional Change (2) Managing Contractors (5) Financing (6) Writing/Communications (7) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Partnerships Marketing/Public Relations Problem Solving Transportation Fundamentals

Recommended Core Training and Education for Program/ Agency Managers

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or
	✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or
	✓ The National ITS Architecture : An Introduction for Senior FTA Staff (FTA)
	T NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	✓ ITS and the Transportation Planning Process (NHI)
	For Transit Managers:
	✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)
	✓ ITS Telecommunications Overview (NHI)
	* Course in procurement and legal issues (U.S. DOT)
	* Introductory courses on the software development process, software integration, and performance measures and testing (U.S. DOT, vendors, and universities)
	* Introductory course on software applications such as databases, data analysis and management, and internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Courses on project management (U.S. DOT, universities and junior colleges)
	* Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)

Specialized Training	✓ Managing Systems Integrators (ITSA)
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Software Acquisition (NHI)
	✓ Lessons in ITS Procurement (NHI)
	* Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Advanced course in writing business plans/ project plans (U.S. DOT, universities, professional associations)
	* Course in marketing/public relations basics (universities, junior colleges)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Seminar on ITS Legal Issues
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	* ITS America's Legislative Affairs web site: http://www.itsa.org/legislative.html

ITS Curriculum — Inter-jurisdictional Coordinators

Role Description: Inter-jurisdictional Coordinators facilitate cooperative structured working arrangements with all participating stakeholders. This involves identifying and bringing on all necessary agencies which can include police, fire, emergency as well as State and local transportation organizations, and private sector firms. Given that metropolitan areas often cross many jurisdictions, this role is particularly important for traffic signal coordination and Transportation Management Center projects. A solid understanding of the ITS planning process as well as the legal issues involved in policy changes is important for this role. Given the nature of ITS projects, it requires working with many jurisdictions, establishing agreements, and defining roles and levels of coordination.

Metropolitan ITS projects often cross jurisdictions given their integrative features. Thus, an Inter-jurisdictional Coordinator, who often is also the project manager or regional champion, can coordinate with various parties to overcome organizational and institutional barriers.

Functions and Responsibilities:

- Facilitate integration across jurisdictions and agencies.
- Track regional ITS deployments to identify opportunities for integration, leveraging of resources, and elimination of redundancies.
- Bring stakeholders from various agencies on board.
- Assist with policy, rules, and regulations changes when needed.

The following is a list of the recommended competencies to build the breadth and depth required for Inter-jurisdictional Coordinators:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness National ITS Architecture ITS Standards Partnerships Procurement Operations Transportation Fundamentals	Organizational/Institutional Change (2) Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change ITS Legal Issues

Recommended Core Training and Education for Inter-jurisdictional Coordinators

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Telecommunications Overview (NHI)
	✓ Lessons Learned in ITS Procurement (NHI)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)

Specialized Training	✓ ITS and the Transportation Planning Process (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Shared Resources for Telecommunications (NHI)
	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Course in procurement and legal issues (U.S. DOT)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Seminar on ITS Legal Issues
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	* ITS America's Legislative Affairs website: http://www.itsa.org/legislative.html

Definitions of ITS Competencies, Critical Knowledge & Skills, and Sources of PCB Training and Education

The following pages present a guide that identifies the available ITS training and education by competency. The guide also includes a more detailed definition of each competency, including a breakdown of the “bundled” critical knowledge and skills that comprise the competency. The top ten competencies are presented first, as it is assumed that these are the subjects most people will be interested in.

The training and education courses are listed using the same symbols as the curricula: a checkmark denotes courses that are identified and available with the presenting organization listed in parentheses; a star denotes courses, reading materials, and web sites that should be easily accessible from the organizations listed in parentheses; and a diamond denotes courses and reading materials that have not been identified. These courses and materials may exist or may need to be developed. Also included, is a notation where materials are available on the ITS Electronic Document Library (EDL).

• Systems Integration (1)	57-59
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• Technology Options (3)	62-63
• Systems Analysis and Design (4)	64-66
• Managing Contractors (5)	67
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• Writing/Communications (7)	70
• ITS Planning (8)	71-72
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• Data Analysis and Management (10)	75-76
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Competency #1 - Systems Integration: A comprehensive transportation system comprises a number of smaller individual transportation organizations and their facilities. The “system” encompasses all of them, even though each is complete and functional in its own right. Systems integration refers to bringing together specific components or devices with the appropriate connections. These devices include mechanical, electrical, software, hardware, telecommunications, fiber optics, microwave components or radio. Each device’s internal performance, its communication links to other devices and the system, the data input/output or manipulation, and the control mechanisms are part of a complex chain with many, potential “weak” links. The devices and the system as a whole must work properly and communicate accurately to the system with timely information to be of any use.

CRITICAL KNOWLEDGE AND SKILLS		AVAILABLE TRAINING/EDUCATION		
		From U.S DOT PCB Catalog		Other Sources
		What	Access	
Transportation and ITS deployment operations	Awareness	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS- Metropolitan ✓ Deploying Integrated ITS- Rural 	<ul style="list-style-type: none"> NHI NHI 	* Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications 	<ul style="list-style-type: none"> NTI 	
National ITS Architecture and Interim Guidance on Conformity	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	<ul style="list-style-type: none"> U.S. DOT FTA 	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by professional associations and vendors
	Specialized	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment -- Public ✓ Using the National ITS Architecture for Deployment -- Private ◇ Turbo Architecture 	<ul style="list-style-type: none"> U.S. DOT U.S. DOT U.S. DOT 	

(Systems Integration, cont' d)

Systems engineering and device configuration	Awareness			* Courses on systems engineering and electrical engineering offered by universities and vendors
	Specialized			
Telecommunications engineering	Awareness	✓ ITS Telecommunications Overview	NHI	* Recommended reading: JPO' s <i>Telecommunications Resource Guide</i> * Courses on telecommunications engineering, networking and fiber optics offered by universities and vendors
	Specialized	✓ ITS Telecommunications Analysis	NHI	
Install and integrate hardware and software in networks and integration with existing systems	Awareness			* Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors * Recommended reading: * <i>Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in the USA: FY 1997 Results</i> , FHWA-JPO-99-001 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i> , DOT-T-94-25 (EDL)
	Specialized			
Data and database management	Awareness			* Courses on data analysis, management and databases offered by universities and professional associations
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications	NTI NTI	
ITS Standards, protocols, and interfaces	Awareness	✓ NTCIP and ITS Standards – What Do They Mean for You?	ITE	
	Specialized	◇ National ITS Standards Training Modules	U.S. DOT	
Risk Analysis	Awareness			* Courses in public sector financial management: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized		U.S. DOT	

(Systems Integration, cont' d)

Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Electronics	Awareness	✓ Advanced Transportation Management Technology Workshop ✓ Procuring New Technologies for Transit ✓	FHWA NTI	
	Specialized	✓ Freeway Traffic Operations ✓ Traffic Control Software and Signalization ✓ Computerized Traffic Signal Systems ✓ Advanced Traffic Signal Controllers ✓ HOV Facilities ✓ Sensors, Data Exchange, and Interoperability ✓ NTI Workshop on Advanced Technologies and Innovative Practices for Transit ✓ Geographic Information Systems: Transit Applications	NHI NHI NHI NHI NHI ITS America NTI NTI	
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		* Course in writing business plans and/ or project plans offered by U.S. DOT, universities or professional associations * Course in project management offered by U.S. DOT, universities or junior colleges * Course in negotiations offered by universities or professional associations
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	

Competency #2 – Organizational/institutional change: ITS will challenge agencies to change their mission and approach to operations as advanced technology deployments become more interagency and systems-oriented. Given that agencies are accustomed to operating based on modal thinking, institutional issues become the greatest non-technical barrier to ITS deployments. These issues will address how agencies can leverage funding, facilities and staff to avoid redundancies. It will also concern how agencies can plan, design, install, operate, and maintain ITS more effectively through the cooperation of multiple stakeholders.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Identifying Stakeholders/ Coalition Building (also, see competency definition on page 70)	Awareness	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff ✓ Deploying Integrated ITS — Metropolitan ✓ Deploying Integrated ITS —Rural 	<p>NHI</p> <p>NHI</p>	<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i>, FHWA-JPO-99-032 (EDL) * <i>The New York-New Jersey-Connecticut Metropolitan Model Deployment Initiative: A Review of the Initial Negotiations Process</i>, FHWA-JPO-98-033 (EDL)
	Specialized			
Understanding the Political Environment	Awareness			<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Traveling with Success: How Local Government Use Intelligent Transportation Systems</i>, FHWA-JPO-96-009 (EDL) * <i>ITS Market Resource Guide: Federal, State, and Local Contacts in ITS</i>, ITS America.
	Specialized			
Policy Skills	Awareness			
	Specialized			

(Organizational/Institutional Change, cont' d)

Financing	Awareness			* Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting offered by U.S. DOT, universities or junior colleges
	Specialized	<ul style="list-style-type: none"> ✓ Shared Resources for Telecommunications ✓ ITS Software Acquisition 	NHI NHI	
Project Evaluation	Awareness	✓ Transit Performance Evaluation: Using Information-Based Strategies	NTI	* Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, cost/benefit analysis after deployment		
Partnerships	Awareness	✓ ITS Public/Private Partnerships	NHI	
	Specialized	✓ Shared Resources for Telecommunications	NHI	
Procurement	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	* Courses in procurement and legal issues offered by U.S. DOT * Recommended reading in ITS Institutional and Legal Issues (search on the EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Procuring New Technologies for Transit ◇ Seminar on ITS Legal Issues ◇ Seminar on using and writing ITS contracts and ITS specifications 	NTI	
Organizational change/ Change Management	Awareness			* Courses in change management offered by business schools, universities, or professional associations * Courses in marketing and public relations offered by universities or professional associations * Courses in negotiations offered by U.S. DOT, universities or professional associations
	Specialized			

Competency #3 - Technology Options: ITS introduces the application and use of advanced technologies into surface transportation. With most capital projects, transportation professionals have not required a background in high tech. However, in ITS, in order to understand the range of options available, new or enhanced skills to choose the most appropriate technology are needed. These technologies generally include communications and networks, computers and computing technologies that constitute information systems, diagnostics, electronics, and detection and surveillance technologies. Skills needed include understanding the nomenclature, specifications, functional use and limitations of the various technologies, and the difference between competing products or solutions.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Range of ITS technologies and Electronics	Awareness	<ul style="list-style-type: none"> ✓ Intelligent Transportation Systems Awareness Seminar ✓ ITS in Transit 	<ul style="list-style-type: none"> NHI FTA 	
	Specialized	<ul style="list-style-type: none"> ✓ Advanced Transportation Management Technology Workshop ✓ Incident Management ✓ Freeway Traffic Operations ✓ Traffic Control Software and Signalizations ✓ Computerized Traffic Signal Systems ✓ Advanced Traffic Signal Controller ✓ NTI Fellows Workshops on Advanced Technologies and Innovative Practices for Transit ✓ Procuring New Technologies for Transit ✓ High Occupancy Vehicle Facilities ✓ Video Communications Systems ✓ Traffic Management Systems ✓ Traffic Surveillance Systems 	<ul style="list-style-type: none"> FHWA NHI NHI NHI NHI NHI NTI NTI NHI (TBD) Vendors Vendors Vendor 	

(Technology Options, cont' d)

Technology benefits and performance assessment	Awareness			
	Specialized	<ul style="list-style-type: none"> ◇ Use of the CORSIM Computer Traffic Simulation Model ◇ Other planning models ✓ Intelligent Transportation Systems for Transit: Solving Real Problems ✓ Reinventing Transit: Planning Information-Based Transit Services ✓ Transit Performance Evaluation: Using Information-Based Strategies 	U.S. DOT NTI NTI NTI	
Writing specifications and procurement	Awareness			* Recommended reading: <i>The Road to Successful ITS Software Acquisition, Executive Summary</i> FHWA-JPO-98-037, <i>Volume 1: Overview and Themes</i> , FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i> , FHWA-JPO-98-036 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ ITS Software Acquisition ◇ Lessons Learned in ITS Procurement ◇ Seminar on using and writing ITS contracts and ITS specifications 	NHI	
Repair and Maintenance	Awareness			* Courses on repairing and maintaining electronics offered by vendors, technical/vocational schools, universities * Repair and maintenance procedures manuals received from vendors
	Specialized			
Training on ITS devices and equipment	Awareness			* Courses offered by vendors after installation * Operations procedures manuals received from vendors
	Specialized			
Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	<ul style="list-style-type: none"> ◇ Workshop on setting ITS systems performance measures, and inspection and testing 		

Competency #4 - Systems Analysis and Design: ITS requires designing systems using a comprehensive integrative approach. Include identifying user needs, analyzing the network infrastructure, and developing or adapting software. In doing this, it is important to clearly define what the system is expected to do now and in the future. Identification of technology risks and costs. The architecture can be used as a tool in the planning stages. One must fully analyze potential capabilities and limitations using a life cycle approach. Looking at investment costs, operations and maintenance costs, staffing and training are all important.

CRITICAL KNOWLEDGE AND SKILLS		AVAILABLE TRAINING/EDUCATION		
		From U.S DOT PCB Catalog		Other Sources
		What	Access	
Transportation and ITS deployment operations	Awareness	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS- Metropolitan ✓ Deploying Integrated ITS- Rural 	<ul style="list-style-type: none"> NHI NHI 	* Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications 	<ul style="list-style-type: none"> NTI 	
User Needs Assessments	Awareness			* Workshops on conducting user needs assessments offered by universities, continuing education programs, or professional associations
	Specialized			
National ITS Architecture and Interim Guidance on Conformity	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	<ul style="list-style-type: none"> U.S. DOT FTA 	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by professional associations and vendors
	Specialized	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment -- Public ✓ Using the National ITS Architecture for Deployment -- Private ◇ Turbo Architecture 	<ul style="list-style-type: none"> U.S. DOT U.S. DOT U.S. DOT 	

(Systems Analysis and Design, cont' d)

Systems engineering and device configuration	Awareness			* Courses on systems engineering and electrical engineering offered by universities and vendors
	Specialized			
Telecommunications engineering	Awareness	✓ ITS Telecommunications Overview	NHI	✓ Recommended reading: JPO' s <i>Telecommunications Resource Guide</i> * Courses on telecommunications engineering, networking and fiber optics offered by universities and vendors
	Specialized	✓ ITS Telecommunications Analysis	NHI	
Install and integrate hardware and software in networks and integration with existing systems	Awareness			* Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors * Recommended reading: * <i>Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in the USA: FY 1997 Results</i> , FHWA-JPO-99-001 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i> , DOT-T-94-25 (EDL)
	Specialized			
Data and database management	Awareness			* Courses on data analysis, management and databases offered by universities and professional associations
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications	NTI NTI	
ITS Standards, protocols, and interfaces	Awareness	✓ NTCIP and ITS Standards – What Do They Mean for You?	ITE	
	Specialized	◇ National ITS Standards Training Modules	U.S. DOT	
Analysis	Awareness			Courses in analysis: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized		U.S. DOT	

(Systems Analysis and Design, cont' d)

Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Electronics	Awareness	✓ Advanced Transportation Management Technology Workshop ✓ Procuring New Technologies for Transit ✓	FHWA NTI	
	Specialized	✓ Freeway Traffic Operations ✓ Traffic Control Software and Signalization ✓ Computerized Traffic Signal Systems ✓ Advanced Traffic Signal Controllers ✓ HOV Facilities ✓ Sensors, Data Exchange, and Interoperability ✓ NTI Workshop on Advanced Technologies and Innovative Practices for Transit ✓ Geographic Information Systems: Transit Applications	NHI NHI NHI NHI NHI ITS America NTI NTI	
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		* Course in writing business plans and/ or project plans offered by U.S. DOT, universities or professional associations * Course in project management offered by U.S. DOT, universities or junior colleges * Course in negotiations offered by universities or professional associations
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	

Competency #5 - Managing Contractors: Many state and local transportation agencies must train in-house staff to manage contractors on ITS projects. First, many agencies have hiring freezes and/or are downsizing leaving many advanced technology projects designed and installed by contractors. Second, university and college graduate transportation programs are not preparing students in the advanced technology skills needed to deploy ITS. Third, given that the hi-tech industry is intensely competitive, it is hard to attract electrical engineers and software developers to the public service given government salary caps. This leaves agencies with many mid-level staff that need to be trained to manage contractors on unfamiliar technology projects.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		* Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	
Procurement	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	* Courses in procurement offered by U.S. DOT
	Specialized	✓ Procuring New Technologies for Transit ◇ Workshop on using and writing ITS contracts and ITS specifications	NTI	
Organizational/ Institutional Issues	Awareness	◇ Workshop on bridging public-private sector differences		* Recommended reading in ITS institutional and legal issues (search on the EDL) * Courses in change management offered by business schools, universities or professional associations * Courses in negotiations offered by U.S. DOT, universities, or professional associations
	Specialized			

Competency #6 - Financing: Currently funding is designated to specific transportation agencies. This “stove-piped” approach inhibits interagency cooperation on ITS projects. Funding mechanisms need to change to alleviate this barrier. Innovative financing such as new tolls, video enforcement ticketing, user fees, and public-private partnerships can also assist in financing ITS projects. Agencies could also initiate new procurement strategies that would leverage their positions to purchase technologies at low cost. Need for funding systems operations and maintenance. Many times funds have been provided to design and install a system but the high costs for operations and maintenance makes running the system prohibitive.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
TEA-21 planning and financing provisions	Awareness	✓ ITS and the Transportation Planning Process	NHI	
	Specialized			
Investment analysis and benefit-cost analysis	Awareness	✓ Intelligent Transportation Systems Awareness Seminar	NHI	* Courses in public sector financial management: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies	NTI	
		✓ Reinventing Transit: Planning Information-Based Transit Services	NTI	
		✓ Intelligent Transportation Systems for Transit: Solving Real Problems	NTI	
Risk analysis	Awareness			* Courses in public sector financial management: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized			

(Financing, cont' d)

Procurement	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	
	Specialized	✓ Procuring New Technologies for Transit ✓ Procuring and Managing Systems Integrators ◇ Workshop on using and writing ITS contracts and ITS specifications	NTI ITS America	* Recommended reading: * <i>Innovative Contracting Practices for ITS, Executive Summary</i> , L.S. Gallegos & Associates, Inc (EDL) * <i>The Road to Successful ITS Software Acquisition, Executive Summary</i> , FHWA-JPO-98-037, Volume 1: Overview and Themes, FHWA-JPO-98-025, and Volume 2: Software Acquisition Process Reference Guide, FHWA-JPO-98-036 (EDL)
Identifying Sources of Funding	Awareness			* Technical assistance from U.S. DOT headquarters, FTA Regional Office ITS Specialists, and FHWA Resource Center and Division Office ITS Specialists
	Specialized			

Competency #7 – Writing/Communications: ITS requires precision and effective interactions between individuals in internal and external organizations. It includes verbal and written communications, including oral presentations and report writing. Negotiations are about persuading individuals to consider an issue or line of reasoning. The types of documents that are important include RFPs, contracts, MOUs, specifications writing, and requirements writing.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Writing specifications and RFPs for ITS projects	Awareness			* Course in writing business plans or project plans offered by U.S. DOT, universities or professional associations
	Specialized	◇ Workshop on using and writing ITS contracts and ITS specifications		
Negotiations	Awareness			* Courses in negotiations offered by U.S. DOT, universities, professional associations
	Specialized			
Managing contractors	Awareness	◇ Workshop on bridging public-private sector differences		
	Specialized	✓ Procuring and Managing Systems Integrators	ITS America	
Technical and Legal issues associated with writing RFPs for ITS deployment	Awareness			* Course on Intellectual Property Rights, Copyrights and Patents from law schools * Recommended reading in ITS institutional and legal issues (search on the EDL)
	Specialized	✓ ITS Software Acquisition ◇ Seminar on ITS Legal Issues	NHI	

Competency #8 - ITS Planning: As ITS capabilities become ready for deployment through the use of regular funding sources, they will encounter the established transportation planning and programming process, requiring choices among competing projects within financial and other constraints. ITS introduces the need for transportation agencies to work more closely to achieve a common regional vision in planning and operations for the transportation system. ISTEA and TEA-21 strongly encourage alternatives to traditional transportation construction. ITS does not change the well-developed planning process. Rather, it necessitates new considerations of ITS projects as alternatives and complements to more traditional capital projects. ITS introduces new federal requirements through the long-range plans (LRPs) and transportation improvement programs (TIPs). It also requires a change in focus from less capital construction to more effective management of the existing transportation network. The role of planning in ITS deployments has increased with ISTEA and TEA-21 to focus on more regional operations and management.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Developing a Regional Concept of Operations for ITS and Mainstreaming ITS	Awareness	<ul style="list-style-type: none"> ✓ ITS and the Transportation Planning Process ✓ An Introduction: The National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	NHI NHI FTA	* Recommended reading: * <i>Integrating Intelligent Transportation Systems within the Transportation Planning Process: An Interim Handbook</i> , FHWA-SA-98-048 (EDL) * <i>Streamlining ITS Planning, Identifying Common Needs: National ITS Architecture</i> , FHWA-JPO-99-013 (EDL# 6865) * <i>Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in the USA: FY 1997 Results</i> , FHWA-JPO-99-001 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications 	NTI	
Transportation Planning fundamentals	Awareness			* Courses on planning, land use, and transportation offered by universities and professional associations
	Specialized			

(ITS Planning, cont' d)

Project Evaluation and Analysis	Awareness	✓ Intelligent Transportation Systems Awareness Seminar	NHI	* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges * Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	✓ Reinventing Transit: Planning Information-Based Transit Services ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Use of the CORSIM Computer Traffic Simulation Model ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment	NTI NTI U.S. DOT	
GIS and mapping	Awareness			
	Specialized	✓ Geographic Information Systems: Transit Applications	NTI	
Negotiations	Awareness			* Course in negotiations offered by U.S. DOT, universities or professional associations
	Specialized			
Environmental and Societal Impacts	Awareness			
	Specialized	◇ Workshop in analyzing the environmental impacts of ITS including air quality, noise, energy and environmental justice		

Competency #9 - Identifying Stakeholders/Building Coalitions: ITS requires that transportation agencies, firms, and professionals who are involved in the shift to systems operations and management work in cooperation with one another. This requires setting goals and developing a regional concept of operations together. Frequently, ITS includes stakeholders from non-transportation agencies, such as law enforcement and emergency personnel.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Developing a Regional Concept of Operations for ITS	Awareness	✓ Deploying Integrated ITS- Metropolitan	NHI	* Systems engineering courses offered by vendors and universities * Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
		✓ Intelligent Transportation Systems Awareness Seminar	NHI	
		✓ Deploying Integrated ITS- Rural	NHI	
	Specialized	✓ Shared Resources for Telecommunications ✓ Planning the Integration of Transit and Traffic ITS Applications	NHI NTI	
Planning fundamentals	Awareness	✓ ITS and the Transportation Planning Process	NHI	* Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	✓ Reinventing Transit: Planning Information-based Transit Services	NTI	
		✓ Planning the Integration of Transit and Traffic ITS Applications	NTI	
User Needs Assessments	Awareness			* Workshops on conducting user needs assessments offered by universities, continuing education programs, or professional associations
	Specialized			
Partnerships and Coalition building	Awareness	✓ ITS Public/Private Partnerships	NHI	
	Specialized	✓ Shared Resources for Telecommunications	NHI	

(Identifying Stakeholders/Building Coalitions, cont' d)

Negotiations	Awareness			* Courses in negotiations offered by U.S. DOT, universities or professional associations
	Specialized			
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	

Competency #10 - Data Analysis and Management: Many transportation professionals desire to understand what data might be produced and how it might be utilized in decision-making. Data can be used to determine traffic trends, patterns and growth for planning, operations and maintenance staff. Data analysts and managers must first look at how data is distributed within and amongst agencies to see if systems are compatible. Linkages might have to be made amongst agencies to see if systems are compatible. Linkages might have to be made amongst systems thus adding a step in conversion and translation of data from one system to the next. The proliferation of data collection devices and advances in database technologies creates a situation in which so much information is available that it can be overwhelming. The value of the system is closely related to how the data is managed. Effective use involves issues such as one-way data sharing versus multiple and real-time sharing as well as data consistency and accuracy, archiving and storage, analysis and interpretation, and privacy.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
National ITS Architecture and Data sharing between agencies	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	U.S. DOT FTA	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by vendors
	Specialized	◇ Turbo Architecture	U.S. DOT	
Transportation and ITS deployment operations	Awareness	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS- Metropolitan ✓ Deploying Integrated ITS- Rural 	NHI NHI	* Systems engineering courses offered by vendors and universities
	Specialized	✓ Planning the Integration of Transit and Traffic ITS Applications	NTI	
Protocols, standards, and interfaces	Awareness	✓ NTCIP and ITS Standards -- What Do They Mean for You?	ITE	
	Specialized	◇ National ITS Standards Training Modules		
Testing procedures, setting performance measures, quality assurance/quality control on databases and software once integrated	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		

(Data Analysis and Management, cont' d)

Data and database management, maintenance and archiving	Awareness			<ul style="list-style-type: none"> * Courses on building databases and relational databases offered by universities * Recommended reading: <ul style="list-style-type: none"> * <i>ITS As A Data Resource: Preliminary Requirements for a User Service</i> (EDL) * <i>Archived Data User Services (ADUS): An Addendum to the ITS Program Plan, Final Version</i>, (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications 	NTI NTI	
Install and integrate hardware and software in networks and ensure systems security	Awareness	✓ ITS Software Acquisition	NHI	<ul style="list-style-type: none"> * Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors * Recommended reading: <ul style="list-style-type: none"> * <i>Protecting Our Transportation Systems: An Information Security Awareness Overview</i>, FHWA-JPO-98-005 (EDL) * <i>The Road to Successful ITS Software Acquisition, Executive Summary</i> FHWA-JPO-98-037, <i>Volume 1: Overview and Themes</i>, FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i>, FHWA-JPO-98-036 (EDL) * <i>Protecting Our Transportation Systems: An Information Security Awareness Overview</i>, FHWA-JPO-98-005 (EDL)
	Specialized			
Training on the use of databases	Awareness			<ul style="list-style-type: none"> * Courses offered by database developers after installation and integration * Operations procedures manuals received from vendors
	Specialized			

ITS Awareness: The introduction of ITS has required that new disciplines bring unfamiliar knowledge and skills to the transportation industry. An understanding of what ITS is comprised of and the scope of the program and its goals, is a critical and basic element in achieving effective and successful ITS deployments and operations. ITS Awareness is the one competency area that is not a mix of knowledge and skills. Instead, it is being cognizant of ITS and having:

- an understanding of what ITS is, why it came about, and what it achieves;
- vocabulary and terminology that is common to ITS;
- a working definition of ITS —the components, how they fit together, and methods of deploying and operating;
- a sense of the role transportation professionals and their agencies perform in deploying and operating the transportation system with ITS, and;
- an understanding of the benefits that result from systems operations and management of the transportation system and from interagency cooperation to achieve intermodalism;
- an understanding of the ITS program areas applicable to the type of planned deployment (each program area has its own page at the end of this resource guide).

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Awareness	Awareness	✓ Intelligent Transportation Systems Awareness Seminar	NHI or internet	* Recommended reading: * <i>1996 ITS Report to Congress</i> , FHWA-JPO-97-026 (EDL) * <i>1997 ITS Report to Congress</i> , FHWA-JPO-98-034 (EDL) * <i>ITS Benefits: Continuing Successes and Operational Test Results</i> , FHWA-JPO-98-002 (EDL) * <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	✓ Deploying Integrated ITS—Metropolitan ✓ Deploying Integrated ITS—Rural	NHI NHI	

National ITS Architecture: To realize the full potential of ITS, a unified framework for integration, called “the National ITS Architecture” was developed to guide the coordinated deployment of ITS by public agencies and private organizations alike. The National ITS Architecture defines the functions performed by ITS components and the various ways in which they can be interconnected. The Architecture is a tool that allows agencies to envision systems, and design projects and deployment approaches for meeting near-term needs while keeping options open for eventual system expansion and integration. The National ITS Architecture does not represent a specific design. Rather, it provides decision points from which stakeholders can work together to make the vision of a unified ITS for their region a reality. The Architecture provides choices that allow deployments to be tailored to localized needs and preferences. The Architecture provides advice on where standards are useful for ensuring interoperability.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	U.S. DOT FTA	<ul style="list-style-type: none"> * Courses on National ITS Architecture, NTCIP, and ITS concepts offered by vendors * Recommended reading: <i>Streamlining ITS Planning, Identifying Common Needs: National ITS Architecture</i>, FHWA-JPO-99-013 (EDL# 6865)
Use of the Architecture in planning and design	Specialized	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment —Public Sector ✓ Using the National ITS Architecture for Deployment —Private Sector ◇ Turbo Architecture 	U.S. DOT U.S. DOT U.S. DOT	<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Developing ITS Using the National Architecture: An Executive Edition for Senior Transportation Managers</i>, FHWA-JPO-98-025 (EDL) * <i>National ITS Architecture Transit Guidelines</i>, FHWA-JPO-97-0016 (EDL) * <i>Developing Freeway and Incident Management Systems Using the National ITS Architecture</i>, FHWA-JPO-98-032 (EDL) * <i>Developing Traveler Information Systems Using the National ITS Architecture</i>, FHWA-JPO-98-031 (EDL) * <i>Developing Traffic Signal Control Systems Using the National ITS Architecture</i>, FHWA-JPO-98-026 (EDL)

(National ITS Architecture, cont' d)

Integration with existing infrastructure	Awareness	◇ Modules on tracking existing infrastructure		<ul style="list-style-type: none"> * Course on systems engineering and integration offered by universities * Recommended reading: <ul style="list-style-type: none"> * <i>Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY 1997 Results</i>, FHWA-JPO-99-001 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i>, DOT-T-94-25 (EDL)
	Specialized			

Partnerships: ITS introduces the opportunity for, and in some cases has required, that agencies and firms work closely together to share resources, costs, risks and rewards of reaching project goals. Partnering takes many forms in ITS depending on the project and partners. It includes public-public partnerships among agencies and public-private partnerships between agencies and firms.

Frequently, forums that are used to build coalitions also provide opportunities for recognizing mutually beneficial partnerships. Partnerships have basic legislative and financial parameters and barriers. They require clear documentation—either Memorandums of Understanding (MOUs) or contracts—describing many important issues. It is important to include staff at all levels in structuring partnership agreements to ensure buy-in and the feasibility of the goals. The following should be considered when structuring partnerships:

- partner's expectations, goals and steps for achieving them;
- the agency's or firm's authority, responsibilities, technical capabilities, statutory limitations, time and funding constraints;
- the agency's or firm's priorities regarding the partnership (for example, after systems installation and testing, which partner will maintain the system?);
- market requirements and financial stability;
- responsibilities regarding decision-making during incidents, control of ITS devices, and data sharing;
- provisions for sharing software and hardware, staff, and operations and maintenance costs;
- contract clauses that clearly spell out how monies will be distributed and contract clauses that describe that agency personnel staffed on the project have the technical expertise needed to do the job.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education			
		From DOT PCB Catalog		Other Sources	
		What	Access		
Benefits of Partnering	Awareness	✓ Public/Private Partnerships	NHI	* Recommended reading: <i>PCB Shared Resources: Sharing Right-Of-Way for Telecommunications: Guidance on Legal and Institutional Issues</i> , FHWA-JPO-96-0015 (EDL)	
	Specialized	✓ Shared Resources for Telecommunications	NHI		
Structuring Agreements	Awareness			* Course on Intellectual Property Rights, Copyrights and Patents from law schools * Courses in writing contracts and Memorandums of Understanding (MOUs) from U.S. DOT * Recommended reading in ITS Institutional and Legal Issues (EDL) * Recommended reading: <i>The New York-New Jersey-Connecticut Metropolitan Model Deployment Initiative: A Review of the Initial Negotiations Process</i> , FHWA-JPO-98-033 (EDL)	
	Specialized	◇ Workshop on using and writing ITS contracts			

ITS Standards: The foundation of intermodal, interoperable ITS is based on a need for, and compliance with, technical standards. ITS requires that new standards be developed that address, for example, communication protocols. Having these standards brings about many benefits. First, decision-makers can be assured that standardized technologies are being used and no future retrofitting will have to occur. Second, it assures interconnectivity and compatibility of systems. Third, standards allow for the manufacture of “open” or non-proprietary systems, that also allows customers a wider choice of technologies which enables growth of economies of scale and consequently reduced prices. The definition and publication of the complete set of ITS standards should help promote vendor growth and stability, and in turn provide the necessary economies of scale to lower prices.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Applying ITS Standards, protocols, and interfaces	Awareness	✓ NTCIP and ITS Standards —What Do They Mean for You?	ITE	* Recommended web site: http://www.its.dot.gov/standard/standard.htm
	Specialized	◇ National ITS Standards Training Modules		
Relationship to the National ITS Architecture	Awareness	✓ An Introduction: The National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards	U.S. DOT	
	Specialized	◇ National ITS Standards Training Modules		

Software & Hardware Operations: ITS requires an understanding of how to operate computers including various operating systems and software packages. It is similar to Technology Options, but focuses on the *application* of these technologies. This competency is as simple as turning on a computer, to identifying and troubleshooting simple problems, to communicating with systems support for more sophisticated problems. Typical tasks include installing and operating a software package, maintaining files and extracting data, and knowing proper shut down and re-boot procedures. It includes some organizational change in that it changes the way transportation business is done. As one senior executive related, the introduction of computer system networks meant that staff no longer worked in isolation--if one person was not doing their job, it had an effect on others in the system.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Procure hardware and software	Awareness	✓ ITS Software Acquisition ◇ Lessons Learned in ITS Procurement	NHI NHI	* Recommended reading: <i>The Road to Successful ITS Software Acquisition, Executive Summary FHWA-JPO-98-037, Volume 1: Overview and Themes</i> , FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i> , FHWA-JPO-98-036 (EDL)
	Specialized			
Install and integrate hardware and software in networks	Awareness			* Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors
	Specialized			
Operate and maintain networks, servers and software	Awareness			* Courses on the software development process, programming and languages offered by universities, technical/vocational schools, or junior colleges * Courses on operating and maintaining networks and software, and inspection and testing of systems offered by vendors, technical/vocational schools, or universities
	Specialized			

(Software and Hardware Operations, cont' d)

Data and database management and maintenance	Awareness			* Courses on data analysis, management and databases offered by universities and professional associations
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications	NTI NTI	
Software Applications	Awareness			* Courses on software applications such as word processing, spreadsheets, databases, or internet applications offered by junior colleges, universities, agency training programs, professional associations or software vendors
	Specialized			
Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Integration with existing systems, expandability and extendability	Awareness			* Course on systems engineering and integration offered by universities
	Specialized			

Software Development: Software is the heart and blood of computer systems. Many issues must be considered in software development since the process is often fraught with cost overruns and lack of usability. Decisions on when to develop software from scratch and when to modify must be made. Life cycle and cost analyses are done to support these decisions and monitor software development costs in the near and long term. Device control, transmission protocols, data capture and storage are elements of software development. Data sharing is also a crucial element. Decisions on what data gets shared with whom must also be done. Agencies can collaborate on projects to maximize return on costly development cycles. Extendibility and expandability of the software must also be considered. Maintenance issues such as upgrades, the software's reliability, backups and redundancies all have to be addressed. Related issues of hardware procurement must be evaluated so the system has the right platform to operate the software. Developers must have a thorough understanding of the transportation problem the software is aimed to address. This requires a good understanding of transportation fundamentals and terminology.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Software Development	Awareness			<ul style="list-style-type: none"> * Courses on the software development process, programming and languages offered by universities, technical/vocational schools, or junior colleges * Courses on operating and maintaining networks and software, and inspection and testing of systems offered by vendors, technical/vocational schools, or universities
	Specialized			
Software Acquisition	Awareness			<ul style="list-style-type: none"> * Course on Intellectual Property Rights, Copyrights and Patents from law schools * Courses in writing contracts and Memorandums of Understanding (MOUs) from U.S. DOT * Recommended reading in ITS Institutional and Legal Issues (EDL) * Recommended reading: <i>The Road to Successful ITS Software Acquisition, Executive Summary</i>, FHWA-JPO-98-037, <i>Volume 1: Overview and Themes</i>, FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i>, FHWA-JPO-98-036 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ ITS Software Acquisition ◇ Lessons Learned in ITS Procurement 		

(Software Development, cont' d)

Electrical Engineering	Awareness			* Courses in electrical engineering and wiring networks offered by universities
	Specialized			
Human Factors	Awareness			* Courses in software engineering and human factors, especially human interface design, offered by universities * Recommended Reading: <i>Design of an ITS Level Advanced Traffic Management System: A Human Factors Perspective</i> , FHWA-JPO-
	Specialized			
Analysis	Awareness			* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges
	Specialized			
User Needs Assessment	Awareness			* Workshops on conducting user needs assessments offered by universities, continuing education programs, or professional associations
	Specialized			
Integration with existing systems, expandability and extendability	Awareness			* Course on systems engineering and integration offered by universities
	Specialized			
Training on the use of databases and software applications	Awareness			* Courses offered by software and database developers after installation and integration * Operations procedures manuals received from vendors
	Specialized			

ITS Human Factors: ITS introduces and requires making advanced technologies user-friendly. This particularly relates to the ergonomics of technology and system design for Variable Message Signs (VMS) and Traffic Management Centers (TMC). VMS messages, for example, need to be concise and easily readable by transportation users. Great care must go into how much information should be included in a message so that users can read it moving at the speed limit. Therefore, research on driving reaction to VMS should be done. VMS must also be placed in locations where users have enough time to make alternative route decisions. TMC consoles must be designed to be user-friendly for operators. For example, operators need easy access to different control mechanisms in split second time. Consoles should thus be designed to allow for quick usage of key elements in a sequential execution that reflects agency procedures. This will help operators to be more comfortable in executing their tasks. Human factors research also can allow for a more comfortable transition from manual to automated functions in that users will slowly trust computer capabilities.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Human Factors in ITS	Awareness			* Recommended reading: * <i>Summary reports on Human Factors Research Needs</i> No. FHWA-RD-98-147 and FHWA-RD-98-184 through –188 (EDL) * <i>Design of an ITS-Level Advanced Traffic Management System: A Human Factors Perspective</i> , FHWA-RD-95-181 (EDL)
	Specialized			
Human Factors Engineering	Awareness			* Courses on human factors offered by universities
	Specialized			
Human factors and software engineering	Awareness			* Course on software engineering and human factors, especially human interface design offered from universities
	Specialized			

Procurement: ITS requires changes in contracts and procurement processes. Whereas capital projects are most often based on low-bid, ITS projects may require design-build or fixed price plus fee contracts. Procurement processes can have unique elements because of an agency's culture. For example, agencies may have certain specification requirements and rules of procurement that may be an obstacle to advanced technology purchases. Long approval processes could also burden the project and result in technologies being outdated once deployed. Life cycle analysis and costs should be performed on alternative procurement options. Specification writing is of paramount importance in ITS projects given the newness of technologies. Furthermore, ITS systems are not easily "spec'ed out" due to unique technological, geographical and agency requirements. Thus, standard "off the shelf" contracts are difficult to use. Contracts should be based on the Scope of Work from the RFP instead of the contractor's bid. This will better ensure that project objectives are met since the bid is based on the contractor's capabilities. Contract clauses should clarify source code ownership, testing criteria, use of proprietary platforms and software, and performance standards for contractors. They should also spell out liability and risk sharing, reward sharing, dedication of resources, the extendibility and expandability of the system, use of prototypes, staff training on the system, and warranties. Legislation changes may have to occur in order to allow the usage of new contracts.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Procurement options, contracts and legal issues	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	* Course in procurement and legal issues offered by U.S. DOT * Recommended reading: ITS institutional and legal issues (search on the EDL)
	Specialized	✓ Procuring New Technologies for Transit ✓ Procuring and Managing Systems Integrators ✓ ITS Software Acquisition ◇ Workshop on using and writing ITS contracts and ITS specifications ◇ Seminar in ITS Legal Issues	NTI ITS America NHI	
Identifying Sources of Funding	Awareness			* Technical assistance from U.S. DOT headquarters, FTA Regional Office ITS Specialists, and FHWA Resource Center and Division Office ITS Specialists
	Specialized			

Project Evaluation: Project evaluation is about measuring if the desired objectives were achieved. Project managers must think of project evaluation from the beginning by identifying what are the critical factors for success and what are the project milestones to get there. This must be written into the Scopes of Work, Requests for Proposals and contracts. Periodic analysis of whether the project is effectively meeting these critical factors and milestones is then done. A final evaluation of the project will analyze if the investment was worth the benefits it generated. It will also hold good lessons for future projects. Interviewees noted that it is difficult to do final project evaluations since no funds are allocated for it. Other interviewees noted that federal agencies could fund or perform the evaluations to ensure impartiality.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Analysis	Awareness			* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges
	Specialized			
Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Project Evaluation	Awareness	✓ Transit Performance Evaluation: Using Information-Based Strategies	NTI	* Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, cost/benefit analysis after deployment		
Technology benefits and performance assessment	Awareness			
	Specialized	◇ Use of the CORSIM Computer Traffic Simulation Model ◇ Other planning models ✓ Intelligent Transportation Systems for Transit: Solving Real Problems ✓ Reinventing Transit: Planning Information-Based Transit Services ✓ Transit Performance Evaluation: Using Information-Based Strategies	U.S. DOT NTI NTI NTI	

Project Management: ITS requires more project/business management skills than in the past. In ITS, project management takes on the features of being multi-agency, multi-discipline, and multi-jurisdictional with a high technology orientation. This includes ensuring that the deployment project is coordinated with other ITS deployments occurring within the region and that consideration is given to the operations, maintenance, and evaluation of the systems in the planning and design stages. ITS project management highlights overcoming the institutional obstacles that exist, especially as networks connect agencies and data, and employees find their work environment evolving toward technological interdependency. As a result, ITS project management requires a mix of skills that broadly fall into the categories of managerial, technical, financial, strategic planning and evaluation.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Technical Management: managing the technical feasibility, and related issues such as extendability, expansion, or systems security; applying the principles of systems, electrical, and telecommunications engineering.	Awareness	◇ Workshop on writing ITS specifications		* Course on the software development process and software engineering offered by universities * Course on the principles of systems engineering offered by universities * Recommended reading: <i>Protecting Our Transportation Systems: An Information Security Awareness Overview</i> , FHWA-JPO-98-005 (EDL)
	Specialized			
Financial Management: managing the budgeting, accounting, tracking, and procurement efforts	Awareness	◇ Workshop on writing and using ITS contracts		* Course in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting procedures, and use of Gantt charts offered by universities, junior colleges, and U.S. DOT
	Specialized			
Analysis	Awareness			* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges
	Specialized			

(Project Management, cont' d)

Strategic Planning: coordination with other deployments and construction activities; coordinating cross-agency work; applying the principles of the National ITS Architecture.	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff ◇ Workshop on ITS Project Management 	FHWA FTA	<ul style="list-style-type: none"> * Course on project management from U.S. DOT, universities or junior colleges * Course on writing business plan/project plans from U.S. DOT, universities, or professional associations
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications ✓ Using the National ITS Architecture for Deployment —Public Sector ✓ Using the National ITS Architecture for Deployment —Private Sector ◇ Turbo Architecture 	NTI FHWA FHWA	
Management: managing contractors; building and managing intra-agency and inter-agency teams; obtaining appropriately qualified staff, possibly designing new positions; managing organizational change	Awareness	<ul style="list-style-type: none"> ✓ Public/Private Partnerships ✓ Procuring and Managing Systems Integrators ◇ Workshop on bridging public-private sector differences 	NHI ITS America	<ul style="list-style-type: none"> * Course in change management offered by business schools or universities * Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i>, FHWA-JPO-99-032 (EDL)
	Specialized			
Project Evaluation: setting performance measures; designing test and evaluation methodologies	Awareness	<ul style="list-style-type: none"> ✓ Transit Performance Evaluation: Using Information-Based Strategies 	NTI	<ul style="list-style-type: none"> * Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	<ul style="list-style-type: none"> ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, cost/benefit analysis after deployment 		
Operations: planning for operations in the design stage; managing the transition from deployment to operations	Awareness	<ul style="list-style-type: none"> ✓ Operating and Maintaining ITS 	ITE	
	Specialized			

Operations: Deploying ITS technologies results in the ability to better operate and manage transportation systems to achieve safety, efficiency, better response time, and better mobility. The knowledge and skills involved in operations form a foundation for professionals to understand how the technologies, the network linkages and the personnel combine to form an ability to manage the transportation systems in real-time. This competency requires a certain level of success in deployment whereby institutional barriers are reduced and a new way of doing business is established. Based on this success, actual operations and management activities can proceed to achieve systems performance goals.

The tasks involved in operations must be considered and planned for in the planning and design stages of deployment.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Managing an operations center and/or a traveler information center	Awareness	✓ Operating and Maintaining ITS	ITE	* Courses in management including budgeting and scheduling from universities, junior colleges, and business schools
	Specialized			
Transportation and ITS operations	Awareness	✓ Deploying Integrated ITS- Metropolitan ✓ Deploying Integrated ITS- Rural	NHI NHI	* Systems engineering courses offered by vendors and universities * Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	✓ Planning the Integration of Transit and Traffic ITS Applications	NTI	
National ITS Architecture and Data sharing between agencies	Awareness	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff	U.S. DOT FTA	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by vendors
	Specialized	◇ Turbo Architecture	U.S. DOT	
Partnerships and cross-agency teamwork	Awareness	✓ Public/Private Partnerships ◇ Workshop on bridging public-private sector differences	NHI	
	Specialized	✓ Procuring and Managing Systems Integrators	ITS America	

(Operations, cont' d)

Staffing, scheduling, and training	Awareness			<ul style="list-style-type: none"> * Course in human resource management including writing job classifications and staffing, offered by business schools and universities * Courses in training and presentations offered by universities, professional associations, and junior colleges * Courses in teaching with advanced technologies * Courses in Instructional Systems Design (ISD)
	Specialized			
Software Applications	Awareness			<ul style="list-style-type: none"> * Courses on software applications such as word processing, spreadsheets, databases, or internet applications offered by junior colleges, universities, agency training programs, professional associations or software vendors
	Specialized			
Data and database management and maintenance	Awareness			<ul style="list-style-type: none"> * Courses on building databases and relational databases offered by universities
	Specialized	<ul style="list-style-type: none"> ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications 	NTI NTI	

ITS Legal Issues: ITS requires addressing legal issues such as intellectual property rights, data and broadcast content, and software & hardware sharing arrangements. These issues should all be addressed in the contract and MOU. Intellectual property rights considerations include making clear who owns the source code and modifications to it when a contractor develops software. *See Competency Category on Software Development.* It also includes licensing agreements for copyrights, trademarks and patents for products and services used and perhaps modified by an agency. Privacy issues are raised with data sharing amongst agencies and with the private sector. Detailed broadcast video of freeway incidents or a failure in traffic signal coordination that results in an accident can leave agencies open to liability. These issues must be addressed in contracts and MOUs to safeguard agency operations. Contracts should also include clauses for testing and prototyping of systems as well as warranties and guarantees for work completed. Changes in legislation may have to occur to allow for public-private partnerships and inclusion of these issues into contracts.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Contracts and procurement	Awareness	<ul style="list-style-type: none"> ◇ Workshop on writing and using ITS contracts and specifications ◇ Lessons Learned in ITS Procurement 	NHI	
	Specialized	<ul style="list-style-type: none"> ✓ Procuring New Technologies for Transit 	NTI	
ITS legal issues including liability and institutional risk	Awareness			<ul style="list-style-type: none"> * Recommended reading in ITS institutional and legal issues (search on the EDL) * Course in legal issues offered by the U.S. DOT * ITS America's Legislative Affairs web site: http://www.itsa.org/legislative.html
	Specialized	<ul style="list-style-type: none"> ◇ Seminar on ITS Legal Issues 		
Intellectual Property Rights/Copyrights/Patents	Awareness			<ul style="list-style-type: none"> * Course on Intellectual Property Rights, Copyrights and Patents from law schools *
	Specialized			
Cooperative Agreements/MOUs, compensation agreements	Awareness	<ul style="list-style-type: none"> ✓ Public/Private Partnerships ✓ Shared Resources for Telecommunications 	<ul style="list-style-type: none"> NHI NHI 	<ul style="list-style-type: none"> * Recommended reading: <i>PCB Shared Resources: Sharing Right-Of-Way for Telecommunications: Guidance on Legal and Institutional Issues</i>, FHWA-JPO-96-0015 (EDL)
	Specialized			

Marketing/Public Relations: Marketing and public relations has become a critical part in the management of ITS projects. The public needs to be aware of the changes resulting from projects and be encouraged to use ITS products and services. Politicians and decision-makers need to see the benefits of ITS projects to continue funding and consideration of additional ITS. Marketing ITS products and services begins with the selection of the most effective message, easily comprehended, that will motivate the public to use ITS and demonstrates its benefits. This message will be well packaged and distributed. Decisions on the best way to reach customers—through radio, television, bus advertisements, pamphlets, etc. are made. Agency approvals and clearances for marketing campaigns may be necessary. Suitable administrative and control procedures for effective operation of advertising, sales promotion, publicity, merchandising, and other communication activities, whether they be in-house or contracted out, may also have to occur. In addition, transportation officials must have good public relations skills in order to communicate with the public and politicians using “laymen’s terms” and not transportation jargon.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Marketing and public relations skills	Awareness			* Courses in marketing and public relations offered by universities and junior colleges.
	Specialized			
Marketing ITS to Agency Senior Decision Makers, and Appointed and Elected Officials	Awareness			* Recommended reading: * <i>Marketing ITS Infrastructure in the Public Interest</i> , FHWA-JPO-98-029 (EDL) * <i>Traveling with Success: How Local Government Use Intelligent Transportation Systems</i> , FHWA-JPO-96-009 (EDL) * <i>ITS Market Resource Guide: Federal, State, and Local Contacts in ITS</i> , ITS America.
	Specialized			
Marketing ITS to the Traveling Public and engaging the media	Awareness			◇ Case studies on the best practices and lessons learned from ITS deployment projects and engaging the media and traveling public
	Specialized			

Problem Solving: ITS requires recognizing and defining problems that arise during the stages of an ITS project. Issues arise due to the multitude of agencies and people involved in projects. Problem solving requires analyzing relevant information and looking at alternative solutions. Conflict management involves anticipating potential conflicts and resolving confrontations, disagreements, and complaints in a constructive manner when they do occur. This competency is about identifying and dealing with problems diplomatically and effectively.

Unlike the other competencies, it is not a bundle of knowledge and skills, but rather an ability to apply the skill of problem solving when applying the other competencies. To facilitate building problem solving capacity, the PCB program will focus future efforts on creating a series of hands-on initiatives. Workshops, labs and case studies are proposed to address needs related problem solving for the following topics:

- ⇒ Managerial/Administrative Skills: Managing contractors, negotiations, writing specifications, institutional issues.
- ⇒ Technical Skills: Equipment installation, maintenance, troubleshooting.

Systems Support & Maintenance: The Systems Support and Maintenance competency consists of a thorough knowledge of the computer hardware, operating systems, and application software. It is most often site-specific, so that the support person is able to install, maintain and troubleshoot both the in-house hardware and software. Given that ITS deployments have extensive computer systems that collect, organize and disseminate information to different agency departments as well as other agencies, Systems Support and Maintenance Technicians have added responsibilities for which further professional capacity building may be needed.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Network Administration	Awareness			* Course in systems administration including maintenance of servers, backing up servers, client account maintenance, repair and troubleshooting
	Specialized			
Software installation and updating	Awareness			* Course in systems administration that includes software installation, maintenance, upgrades, and troubleshooting
	Specialized			

Transportation Fundamentals: It was discovered in interviews that a basic grasp of transportation principles, both highways and transit, was critical for system integrators and software engineers to do transportation applications. This requires a basic understanding of the vocabulary and concepts common to transportation agencies, for example, “dwell time” (which refers to the length of time a bus spends on a given stop). Along with terminology and traffic concepts, one needs an understanding of the modal functions that drive the mission, design and operation of an agency’s system. This need was mostly expressed in context of consultant deficiencies. While many consultants are well versed in the design and installation of technologies, they lack knowledge on how their work solves transportation problems. This can prevent them from designing systems that most fully satisfy the needs of their clients. See Competency Category on Systems Analysis & Design. This competency is about ensuring that non-civil engineers are knowledgeable on how their work is being applied to transportation problems.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Traffic/Transit operations vocabulary	Awareness			* Course on the basics of transportation engineering to learn the vocabulary and fundamentals of traffic and/or transit offered by universities, transportation professional associations, or vendors
	Specialized			
Transportation planning basics	Awareness			* Course on the basics of transportation planning offered by universities
	Specialized			
Operations	Awareness	✓ Operating and Maintaining ITS	ITE	
	Specialized			
Intermodalism	Awareness			
	Specialized			

Legislative & Policy Change: ITS requires a good understanding of agencies' legislative authority in providing new transportation solutions. ITS projects such as HOV lanes and new revenue sources like video enforcement ticketing may require legislative changes to deploy. This involves identifying obstacles in state constitutions and laws as well as federal regulations that restrict the types of contracts and partnerships allowed. Jurisdictional boundary issues such as different procurement processes and contracting methods must also be addressed.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Promoting and marketing ITS to Senior Agency Decision Makers, and Appointed and Elected Officials	Awareness			<ul style="list-style-type: none"> ◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to accommodate ITS * Course in negotiations offered by universities or junior colleges
	Specialized			
Understanding the Political Environment and Policy Skills	Awareness			<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Traveling with Success: How Local Government Use Intelligent Transportation Systems</i>, FHWA-JPO-96-009 (EDL) * <i>ITS Market Resource Guide: Federal, State, and Local Contacts in ITS</i>, ITS America.
	Specialized			

Freeway Management Systems: Systems that provide information to motorists and detect problems to increase capacity, and minimize congestion caused by crashes.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ High Occupancy Vehicle Facilities ✓ Freeway Traffic Operations 	NHI NHI	<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Emissions Management Using ITS Technology</i>, FHWA-JPO-99-039 (EDL# 6325) * <i>Developing Freeway and Incident Management Systems Using the National ITS Architecture</i>, FHWA-JPO-98-032 (EDL)
Technologies	<ul style="list-style-type: none"> ✓ Traffic Control Software and Signalization 	NHI	

Incident and Emergency Management Systems: Systems that enable communities to identify and respond to crashes or breakdowns with the best and quickest emergency services, thereby minimizing clean-up time. Coordinated emergency response ensures that the closest available and most appropriate emergency response unit can respond to a crash.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept and Technologies	✓ Incident Management	NHI	* Recommended reading : * <i>Enhancing Public Safety, Saving Lives: Emergency Vehicle Preemption</i> , FHWA-JPO-99-002 (EDL #6871) * <i>Speeding Response, Saving Lives: Automatic Vehicle Location Capabilities for Emergency Services</i> , FHWA-JPO-99-003 (EDL# 6866) * <i>Faster Response Time, Effective use of Resources: Integrating Transportation Systems and Emergency Management Systems</i> , FHWA-JPO-99-004 (EDL# 6874) * <i>Improving Mobility, Saving Lives: Safety Service Patrols</i> , FHWA-JPO-99-005 (EDL #6872) * <i>Safer Travel, Improved Economic Productivity: Incident Management Systems</i> , FHWA-JPO-99-006 (EDL# 6868) * <i>Sharing Resources, Coordinating Response: Deploying and Operating Incident Management Systems</i> , FHWA-JPO-99-007 (EDL #6869) * <i>ITS Field Operational Test Cross-Cutting Study: Emergency Notification and Response</i> , FHWA-JPO-99-033 (EDL# 6326) * <i>ITS Field Operational Test Cross-Cutting Study: Incident Management: Detection, Verification, and Traffic Management</i> , FHWA-JPO-99-034 (EDL# 6328) * <i>ITS Field Operational Test Cross-Cutting Study: Hazardous Material Incident Response</i> , FHWA-JPO-99-035 (EDL# 6327)

Advanced Traveler Information Systems: Also known as regional multimodal traveler information systems. They are systems that provide road and transit information to travelers, businesses and truckers, so that they can more effectively plan their travel.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			* Recommended reading: * <i>ITS Field Operational Test Cross-Cutting Study: Advanced Traveler Information Systems</i> , FHWA-JPO-99-038 (EDL# 6323) * <i>Developing Traveler Information Systems Using the National ITS Architecture</i> , FHWA-JPO-98-031 (EDL)
Technologies			

Advanced Public Transportation Systems: Updated transit management systems that allow new ways of monitoring and maintaining our Nation's sizable transit fleets through advanced vehicle locating devices, equipment monitoring systems, vehicle diagnostics, and fleet management systems.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ ITS in Transit ✓ ITS Transit Management ✓ Intelligent Transportation Systems for Transit: Solving Real Problems ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Reinventing Transit: Planning Information-Based Transit Strategies ✓ Planning the Integration of Transit and Traffic ITS Applications 	FTA FTA NTI NTI NTI NTI	* Recommended reading: * <i>Better Service, Safer Service: Transit Management for Fixed-Route Systems</i> , FTA.TRI.10.98.1 (EDL# 6875) * <i>Better Service, Greater Efficiency: Transit Management for Demand Response Systems</i> , FTA.TRI.10.98.2 (EDL# 6876) * <i>National ITS Architecture Transit Guidelines</i> , FHWA-JPO-97-0016 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i> , DOT-T-94-25 (EDL) * <i>Advanced Public Transportation Systems: The State of the Art Update of '98</i> FTA-MA-26-7007-98-1 (EDL) * <i>Advanced Paratransit Systems: An Application of Digital Map, Automated Vehicle Scheduling, and Vehicle Location Systems</i> , UCB-ITS-RR-97-1 (EDL)

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Technologies	<ul style="list-style-type: none"> ✓ Procuring New Technologies for Transit ✓ Geographic Information Systems: Transit Applications ✓ Analytic Troubleshooting for the Advanced Technology Bus: Train-the-Trainer ✓ NTI Fellows Workshops on Advanced Technologies and Innovative Practices for Transit 	NTI NTI NTI NTI	* Recommended reading: <i>FTA National Transit Geographical Information Systems Guidelines, Standards, and Recommended Practices</i> , DTRS57-95-P-80861 (EDL)

Advanced Traffic Signal Control Systems: Modernized traffic signal control systems that automatically adjust themselves to optimize traffic flow.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ Computerized Traffic Signal Systems ✓ Traffic Control Software and Signalization 	NHI NHI	* Recommended reading: <i>Developing Traffic Signal Control Systems Using the National ITS Architecture</i> , FHWA-JPO-98-026 (EDL)
Technologies	<ul style="list-style-type: none"> ✓ Advanced Traffic Signal Controller 	NHI	

Electronic Fare Payment Systems: New systems that enable a person to pay for parking, bus and train fares, and tolls by using a single smart card.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			* Visit ITS America' s web site: http://www.itsa.org/payment.html
Technologies			

Electronic Toll Collection Systems: Systems that provide drivers and transportation agencies with convenient and reliable automated transactions. This will dramatically improve traffic flow at toll plazas and increase the operational efficiency of toll collecting.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			<ul style="list-style-type: none"> * Visit ITS America' s web site: http://www.itsa.org/payment.html * Visit a private sector web site for information: http://www.ettm.com
Technologies			

Highway-Rail Intersection Systems: Advances in railroad crossings that are coordinated with traffic signals and train movements, and that notify drivers of approaching trains through in-vehicle warning systems.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			
Technologies			

Commercial Vehicle Operations/CVISN: Electronic systems and networks that allow for simple, cost-effective, and seamless exchange of safety and administrative data, electronic business transactions, and information on commercial vehicle operations and processes. There are four areas of applications to CVISN:

- **Safety assurance programs and services** designed to assure the safety of commercial drivers, vehicles and cargo. These include automated roadside safety inspections and carrier reviews, safety information systems, and onboard safety monitoring.
- **Credential administration programs and services** designed to improve the deskside procedures and systems for managing motor carrier regulation. These include electronic application, purchase and issuance of credentials, as well as automated tax reporting and filing.
- **Electronic screening systems and services** designed to facilitate the verification of size, weight and credential information. These include the automated screening of commercial vehicles at fixed weigh stations and international border crossings.
- **Carrier operations activities and services** designed to reduce congestion and manage the flow of commercial vehicle traffic, such as travel advisory and hazardous materials incident response services. The private sector is taking the lead in implementing fleet and vehicle management technologies and systems that improve motor carrier productivity.

(Commercial Vehicle Operations/CVISN, cont' d)

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ ITS/CVO Program Management ✓ ITS/CVO Basic Awareness Course ✓ ITS/CVO Executive Briefing Session ✓ Introduction to ITS/CVO ✓ ITS/CVO Technical Project Management for Non-Technical Managers 	NTC NTC NTC NTC NTC	* Recommended reading: * <i>Improved Enforcement, Safer Roads for State Agencies: Commercial Vehicle Electronic Screening</i> , FHWA-JPO-99-008 (EDL# 6873) * <i>Achieving Shared Efficiencies Through Cooperative Implementation: Commercial Vehicle Electronic Screening</i> , FHWA-JPO-99-009 (EDL# 6867) * <i>Safer Trucks, Higher Profits for Motor Carriers: Commercial Vehicle Electronic Screening</i> , FHWA-JPO-99-010 (EDL#6870) * <i>ITS Field Operational Test Cross-Cutting Study: Commercial Vehicle Operations —Roadside</i> , FHWA-JPO-99-036 (EDL# 7863) * <i>ITS Field Operational Test Cross-Cutting Study: Commercial Vehicle Administrative Processes</i> , FHWA-JPO-99-037 (EDL# 6324)
Technologies	<ul style="list-style-type: none"> ✓ Understanding ITS/CVO Technology Applications 		

Rural ITS systems: ITS services and applications that are applied to meet the transportation needs of rural areas and small towns, travelers on rural roads, and in the National Highway System. Some rural systems will be extension of metropolitan and CVISN systems, applied to specific rural needs. Other applications are uniquely developed for rural needs. Services that characterize rural ITS are:

- **Traveler safety and security technologies** that alert drivers to hazardous conditions and dangers, and include wide-area information dissemination of site-specific safety advisories and warnings.
- **Emergency services technologies** that automatically mobilize the closest police, ambulances, or fire fighters in cases of collisions or other emergencies—even in the most remote locations.
- **Tourism and travel information services** that provide information to travelers who are unfamiliar with the local rural areas. These services can be provided at specific locations, en route, or well in advance of the traveler's destination.
- **Public traveler and mobility services** that improve the efficiency of transit services and their accessibility to rural residents. Advanced vehicle locating devices and communications systems can help achieve better scheduling, improved dispatching, smart card payment transactions, and advanced ridesharing and ride-matching systems.
- **Roadway operations and maintenance technologies** that improve the ability of our highway workers to maintain and operate rural roads. These include severe weather information systems, early detection of pavement and bridge failures, and immediate detection of dangers to work zone crews.
- **Fleet operations and maintenance systems** that improve the efficiency of rural transit and other rural fleets, such as snowplows and even law enforcement vehicles, through advanced vehicle tracking and on-board equipment monitoring systems.
- **Commercial vehicle systems** that manage the movement and logistics of commercial vehicles in rural settings, and locate them during emergencies and breakdowns. These include applications to improve safety, such as warnings associated with slow-moving vehicles, and scheduling applications for harvest season when vast numbers of trucks are needed during a very small time window.

(Rural ITS systems, cont' d)

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ◇ Workshop that bridges the gap between weather information and transportation needs —what is currently available from the Weather Services ✓ Incident Management 	NHI	<ul style="list-style-type: none"> * Course on fleet management systems available from vendors * Recommended reading: <ul style="list-style-type: none"> * <i>Saving Lives, Improving Transportation Efficiency: Weather Information for Surface Transportation</i>, FHWA-JPO-99-015 (EDL# 6863) * <i>Rural Intelligent Transportation Systems Program Plan</i> (EDL) * <i>Rural Intelligent Transportation Systems Strategic Plan</i> (EDL)
Technologies			<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Technology in Rural Transportation: Simple Solutions</i>, FHWA-RD-97-108 (EDL) * <i>Rural Public Transportation Technologies: User Needs and Applications, Executive Summary</i>, FHWA-RD-98-126 and <i>Final Report</i>, FHWA-RD-98-125 (EDL)

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ITS Joint Program Office: <http://www.its.dot.gov>**

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APPENDIX E: REPORT

BUILDING PROFESSIONAL CAPACITY IN ITS: GUIDELINES FOR DESIGNING AN INDIVIDUALIZED TRAINING AND EDUCATION PLAN

BUILDING PROFESSIONAL CAPACITY IN ITS:

GUIDELINES FOR DESIGNING AN INDIVIDUALIZED TRAINING AND EDUCATION PLAN



US Department of Transportation
ITS Joint Program Office
ITS PCB Program

April 1999

Foreword

This report summarizes a comprehensive effort conducted in the summer of 1998 to more systematically investigate the intelligent transportation systems (ITS) training and education needs of transportation professionals. A team of analysts conducted a series of nearly 200 interviews in an effort to obtain a more detailed understanding of the underlying fundamental knowledge and skills required in support of ITS applications and services. The interviewees spanned a range of ITS involvement from those actively engaged for several years, to those just beginning the process. Thus, the reported needs reflect an important “grass-roots” perspective obtained from the public-sector, private-sector, and the academic community.

This report documents the wide-ranging ITS training and education needs of transportation professionals. An analysis of those needs resulted in the development of a PCB Program strategy to meet those needs both now and in the future. Although the focus of this work is ITS, the analysis also revealed that the fundamental knowledge and skills are applicable to a wider audience of transportation professionals engaged in the operation and management of multimodal surface transportation systems.

The ITS PCB Program is comprised of a partnership of organizations which work cooperatively to provide ITS professional capacity building. That partnership encompasses the public sector, the private sector, and the academic community. It is hoped that this report will be used as a foundation for ongoing dialogue with the multiple partners, stakeholders and transportation professionals everywhere about:

- The process of building professional capacity for ITS;
- The design and delivery of training and education programs that achieve the level of competency required for meeting the challenges of 21st century transportation systems; and
- The most effective and cooperative programmatic ways to meet training and education needs in ITS.

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ITS Joint Program Office, Washington D.C.
April, 1999

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- The Volpe National Transportation Systems Center (VNTSC)
- The Federal Transit Administration's ITS Program
- The Federal Highway's National Highway Institute (NHI) and Office of Personnel and Training.

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Overview: Introduction

Purpose of this Document

This document is a guide for transportation professionals on how to create an individualized training and education plan for enhancing their knowledge and skills for working with ITS. The guide identifies the twenty “ideal” roles that professionals play in ITS and the ITS competencies required for successful performance in each role. Based on these roles and competencies, the guide then presents a curriculum that has been designed to build the competencies recommended for each individual role.

The twenty sets of ITS Curricula recommend training and education courses that are available from three categories of sources: the U.S. DOT training programs, the academic community, and private sector professional associations and vendors. The guide relies upon the reader to make some personal determinations for future development either on his/her own, with a supervisor, and/or with human resources staff:

- (1) The first determination is what role or roles the reader plays in ITS. Many people function in more than one role and therefore need to build a cross-section of ITS competencies.
- (2) The second determination is the level — awareness or specialized — at which the reader currently possesses an understanding of one or more of the ITS competencies. Many professionals have already acquired some level of ITS competence through:
 - Previous education or background experience;
 - Involvement in planning or deployment activities;
 - Self-development by attending conferences, reading journals or participating in ITS committees; or
 - Attending some of the ITS PCB training courses or other courses.
- (3) The third determination is how to go about building the required ITS professional capacity. This will require the reader to develop an individualized plan for learning. It requires the commitment of the reader to determine his/her existing strengths, identify what knowledge areas require further exploration, and pursue those resources which will help bridge his/her knowledge gaps.

The guide is intended to satisfy the needs of professionals who are in search of a greater understanding and awareness of ITS, and for those who want to develop a specialized area of knowledge that will advance their contribution to ITS-related projects. It does not provide recommendations for building professional expertise that comes only through years of study and experience. Instead, the guide is intended to help professionals who have discovered that the requirements of their jobs have changed, want to successfully meet the technological and institutional demands of ITS-related projects, and are interested in advancing their careers in ITS. It also recognizes that the level of knowledge or the extent of any one's contribution will vary depending on the person's role and the composition of the team that is gathered during the different stages of the ITS project.

Overview: Background

What Is ITS Professional Capacity Building

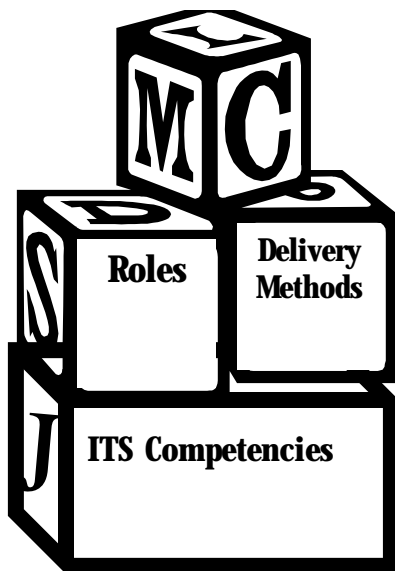
Professional capacity building (PCB) is the process of developing new or enhancing existing knowledge and skills that are required for successful performance in one's job. ITS professional capacity building has been growing in importance since 1991 when Congress charted a new course for the modernization of the country's surface transportation system. The intent of ITS is to achieve greater operational safety and management efficiency by enhancing surface transportation systems with electronics, communications, computer and sensing technologies, known as Intelligent Transportation Systems or ITS.

The move towards applying ITS to surface transportation requires transportation professionals at all levels to incorporate and apply new competencies in their daily work activities. The recent technological revolution in the areas of electronics, telecommunications and computing requires transportation professionals to search for, and access, education and training resources which will enable them to remain professionally current.

This guide highlights the process of building professional capacity for ITS. It uses information gathered from nearly 200 interviews with transportation professionals engaged in ITS around the nation in the summer of 1998. These professionals represented a wide variety of responsibilities and functions in public and private sector transportation agencies and organizations. More detail on these interviews is published in a separate report entitled, *Building Professional Capacity in ITS: Documentation and Analysis of ITS Training and Education Needs in Support of ITS Deployment* (available on the ITS PCB web site at <http://www.its.dot.gov>), which also documents how the U.S. Department of Transportation (DOT) and its PCB partners are addressing ITS professional capacity building needs.

The PCB Building Blocks

For a professional who wants to determine how to build his/her own ITS professional capacity, he/she will need to begin with an understanding of the three PCB "building blocks". Briefly, they are:



- **ITS Roles** — the range of ideal ITS functions and job positions within a transportation agency and/or on an ITS project team.
- **ITS Competencies** — bundled sets of applied knowledge and skills that support successful job performance in ITS.
- **Delivery Methods** — the most accessible ways for professionals to learn about ITS; the ITS PCB Program relies on methods in four categories — training, education, technical assistance, and information dissemination.

Two of these building blocks are used in designing the individualized ITS training and education plans — the roles and the ITS competencies. The third, delivery methods, is described in this report to help professionals identify the most accessible means for

them to receive PCB, and then to request that form of delivery from the PCB program and other PCB providers. The following describes each building block in greater detail.

Range of ITS Roles

The needs assessment study cited above defines twenty “ideal” ITS team roles that professionals perform in ITS. Frequently, professionals play more than one role in their jobs. Additionally, the scope of each role varies among agencies and ITS projects.

The interviews revealed that, in deploying ITS, the most effective performance resulted from dividing the competencies among a team of people and employing them with a strategy similar to the use of a football team’s members throughout a game. In this respect, no one person has to know it all. Instead, each role varies in its competency mix to allow professionals to focus on those areas that are most important for their job functions.

Unfortunately, the majority of transportation agencies are not always in a position to staff these roles due to limitations on hiring, salary caps, and the move toward privatization. A separate companion guide entitled, ***Building Professional Capacity in ITS: Guidelines for Staffing, Hiring, and Designing Ideal Project Teams***, is available on the ITS PCB web site (<http://www.its.dot.gov>) to help managers and agency decision makers identify and decide how to staff the role(s) of the intra- and inter-agency team members.

The ITS roles are listed in Table 1. In structuring an individualized ITS training and education plan, the reader should either individually or with his/her supervisor and/or human resource development personnel, identify the role(s) played. To help, more detail on each role and its responsibilities is provided at the beginning of each curriculum, located on pages 9-55 of this guide.

Table 1: Range of ITS Roles

<p><u>Roles in Developing a Regional ITS Concept of Operations and Planning for ITS</u></p> <ul style="list-style-type: none"> • Champions • Planners • Federal Field Staff 	<p><u>Cross-Cutting Roles</u></p> <ul style="list-style-type: none"> • Business Analysts • Data(base) Analysts and Managers • Contract Specialists • Legal Staff • Marketing / Public Relations Staff • Human Resources Staff • Systems Administrators/ Support Technicians
<p><u>Roles in the Design, Procurement, Installation, Operations & Maintenance, and Evaluation Stages</u></p> <ul style="list-style-type: none"> • Project Managers • Software Developers • Systems Designers / Integrators • Operators • Dispatchers • Drivers • Electronics Inspection and Maintenance Technicians • Operations Managers/Supervisors 	<p><u>Creating Change: Roles for Mainstreaming ITS</u></p> <ul style="list-style-type: none"> • Program/Agency Manager • Inter-jurisdictional Coordinator

ITS Competencies

An ITS competency is a *bundled set of knowledge and skills* that support successful job performance. Knowledge provides the fundamental principles associated with the competency area, and skills help one learn how to apply the knowledge.

Table 2 presents the competencies in four general categories, which characterizes when ITS competencies are needed and why. The competencies in bold and that are ranked, represent the top ten needs in ITS learning. The rankings derive from a series of nearly 200 interviews that were conducted as part of the needs assessment. Twenty-seven ITS competency areas have been defined that encompass the fundamental technical and institutional knowledge and skills required across the ITS stages of project planning, design and deployment and through systems operations, maintenance, and ongoing management.

Detailed descriptions of each of these competencies can be found beginning on page 57 of this guide.

Table 2: Range of ITS Competencies

<p><u>Competencies for Developing a Regional ITS Concept of Operations and Planning for ITS</u></p> <ul style="list-style-type: none"> • ITS Awareness/ITS Topics (see below) • Identifying Stakeholders/Building Coalitions (9) • National ITS Architecture • Partnerships • Financing (6) • ITS Planning (8) 	<p><u>Cross-Cutting Competencies</u></p> <ul style="list-style-type: none"> • Project Management • ITS Legal Issues • Marketing/Public Relations • Writing/Communications (7) • Problem Solving • Data Analysis & Management (10) • Transportation Fundamentals
<p><u>Competencies for the Design, Procurement, Installation, Operations & Maintenance, and Evaluation Stages</u></p> <ul style="list-style-type: none"> • Systems Analysis & Design (4) • Technology Options (3) • ITS Standards • Software and Hardware Operations • Software Development • ITS Human Factors • Procurement • Managing Contractors (5) • Systems Integration (1) • Project Evaluation • Operations • Systems Support and Maintenance 	<p><u>Creating Change: Competencies for Mainstreaming ITS</u></p> <ul style="list-style-type: none"> • Legislative and Policy Change • Organizational/Institutional Change (2) <p><u>ITS Topics:</u></p> <ul style="list-style-type: none"> • Freeway Management Systems • Incident and Emergency Management Systems • Advanced Traveler Information Systems • Advanced Public Transportation Systems • Advanced Traffic Signal Control Systems • Electronic Fare Payment Systems • Electronic Toll Collection Systems • Highway-Rail Intersection Systems • Commercial Vehicle Operations/CVISN • Rural ITS systems

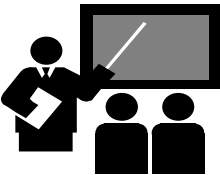



Range of Delivery Methods for Learning ITS

The four primary means of delivering professional capacity building are **training, formal education, technical assistance, and information outreach**. Professionals need to consider what means of learning is most accessible to them. Table 3 provides a more comprehensive list of the methods available for delivering ITS learning that are used by the U.S. DOT and its PCB partners.

The interviews revealed that *the method by which one learns is equally as important as identifying one's role and what one needs to learn*. In today's fastpaced business environment, the more traditional methods of learning, such as training courses or pursuing educational classes, don't always meet the needs of professionals who need information and instruction on -the-job and just-in-time.

In addition, the interviewees made it evident that professionals who were most successful at learning about ITS did so through a wide variety of learning methods. They mixed night -time courses at local universities (education) with constant reading of journals, attendance at conferences, and participation on committees (information outreach). They participated in ITS Scanning Reviews, arranged their own visits to sites with ITS deployments, and called peers about problems, solutions, and experiences (technical assistance). In fact, many of the interviewees were some of the first attendees of the U.S. DOT's PCB Program's ITS courses and seminars (training).

Table 3: Range of ITS Delivery Methods

<p><u>Training</u></p> <ul style="list-style-type: none">• Traditional classroom style• Computer-based training (CBT)• Satellite broadcast of a course presentation• Web-based training (WBT)• Job rotation or exchange program through/with agencies, professional associations, or private sector firms. 	<p><u>Education</u></p> <ul style="list-style-type: none">• University and college semester lecture courses, labs and degree programs.• Certificate programs for continuing education• Technical and vocational school courses, labs, and degree programs• Journeyman and apprenticeship programs 
<p><u>Technical Assistance</u></p> <ul style="list-style-type: none">• Assistance from Federal Field Staff• Mentoring• Peer-to-Peer Network• Consultant/Contractor assistance• Scanning Reviews 	<p><u>Information Outreach</u></p> <ul style="list-style-type: none">• Web site with reports, information and access to technical assistance• Papers on best practices, lessons learned, and successful approaches• Vendor sponsored programs: displays, exhibits, training, Electronic Data Library, Electronic newsletters. 

It is the goal of the ITS PCB Program to utilize the delivery method that most effectively allows the learning to be *tailored to, targeted for, and accessible to* professionals.

“The goal of a 21st century professional capacity building program should be to provide *the right information to the right people at the right time and place, as quickly and conveniently as possible.*”

An interviewee

Steps For Building ITS Professional Capacity

What competencies are needed and at what level, is unique to each individual. Also, the level at which a professional will need to learn an ITS competency is dependent upon the role, or roles, that he/she plays within a transportation agency and/or on an ITS project. The remainder of this document provides tools for individual transportation professionals to determine how to build their own professional capacity in ITS. These tools are:

- A series of *ITS curricula* that recommend, for each role, a sequence of learning.
- A *set of definitions for each competency* that also lists the training, education, technical assistance, and information references that are available to build professional capacity in each competency area.

This document recommends a four step process using these tools for professionals to follow in determining for themselves their own unique mix and learning sequence of professional capacity building in ITS competencies:

- 1) **Step One: Identify your role(s)**
- 2) **Step Two: Determine your current level of ITS competencies**
- 3) **Step Three: Use the ITS Curricula to develop a learning plan**
- 4) **Step Four: Use the definition pages to learn of additional training resources and opportunities**

Step One: Identify Your Role(s)

To begin, use the chart on page 3 to identify what role or roles you perform for your transportation agency or on your ITS project. You may play more than one role and will thus need to combine the curricula when forming a learning plan.

Step Two: Determine Your Current Level of Competencies

After identifying your role, turn to the ITS Curricula listed on pages 9 through 55. For each role, a description of the functions and responsibilities is provided for the reader to ensure the right match to the role. A list of competencies is then recommended to build the ITS competence needed for that role.

At this point, the reader will need to determine his/her current level of ITS competence. It may be that through experience or through education, the reader already possesses the recommended level of one or more competencies. It may also be that the recommended competencies need to be expanded or minimized based on the reality of the reader's role. The key to this step is for the reader to determine the gap that still needs to be filled through further ITS training and education.

Step Three: Use the ITS Curricula to Develop a Learning Plan

The next step is for the reader to consider the curriculum associated with his/her role. If the reader plays more than one role, the curricula will need to be combined. The curricula are designed around U.S. DOT training and education courses and seminars, including those developed by the ITS PCB Program, the National Highway Institute (NHI) and the National Transit Institute (NTI). They also include courses from PCB Program partners such as universities, ITS America (ITSA) and the Institute of Transportation Engineers (ITE).

The curricula provides a sequence for learning at the awareness level and at the specialized level, which are associated with the competency recommendations. The **Awareness Level** provides training to build a basic sense of awareness with an ITS topic or an associated topic, and an overview of the issues and experiences-to-date. The **Specialized level** provides more in-depth knowledge to build a fundamental foundation to many of the principles involved in ITS, and skill-building instruction to provide “how-to” learning for many of the skills needed for ITS.

When using the curricula, it is important to consider how much ITS learning you may already have acquired either on-the-job or in training. The new entrant to ITS will want to begin with the Awareness Training Curricula. Those professionals who have been engaged in ITS for a while may find it more appropriate to begin at the Specialized Level.

Step Four: Use the Definition Pages to Learn of Additional Resources and Opportunities

Other learning resources and opportunities are available. These resources are a mix of training, education, technical assistance and information that can be accessed through the U.S. DOT and its Electronic Document Library (EDL), local universities and LTAP Centers, professional associations, and private sector vendors.

Other resources that complement this learning are listed according to competency areas on pages 57 through 113. These pages list the type of courses one should seek out at local universities, Technical Assistance programs that are available and accessible, and information resources both on the Internet and by hard copy.

Not every resource is listed due to time limitations on identifying them. Thus, the reader is expected to explore other catalogs that are available that provide additional and up-to-date information. These other catalogs can be found through professional associations, local universities, State DOT training programs, or vendors and also on web sites. The definition pages include the more obvious opportunities as a way to provide direction for thinking about other opportunities.

*** It should be noted that, what is missing from both the ITS Curricula and the definition pages, is a level of learning that qualifies a professional to be an expert. For most roles, this expert, “nitty-gritty” background is inherent within the job requirements for the role. For instance, success comes easier if you hire a Marketer for marketing or a Systems Designer for designing your system. The training and education recommended through Awareness and Specialized training would not provide these skills at that level. Instead, the ITS curricula introduce, establish and provide a sound foundation for professionals to enhance their knowledge and skills for working with ITS.

Conclusion

This guide has been developed so that it is practical and easy to use in developing individualized ITS training and education plans. The professional who is seeking a greater ITS awareness, as well as the individual seeking more specialized ITS knowledge and skills can follow the steps outlined in this guide to develop an action plan for securing the training and education required by ITS projects and activities.

The curricula are provided in this guide to assist professionals in building a foundation in ITS. They are not meant as a checklist, nor a certification. ITS competence evolves as the training and education recommended here is supplemented with practical, hands-on knowledge and experience. However, to begin building that foundation, this guide provides the following tools:

- ITS roles to help the reader identify his/her functions and responsibilities;
- ITS competencies to help the reader determine what knowledge and skills are needed;
- A set of ITS Curricula to assist the reader in developing a plan for learning;
- Competency definitions that also describes further opportunities to access learning through training, education, technical assistance, and information outreach.

The ITS Curricula

The remainder of this guide contains the ITS curricula for each ITS role and the definition pages. They both utilize the following set of symbols to identify training and education opportunities:

- ✓ **Specific ITS training courses** that have been developed and are known to be available through the following ITS PCB Program partners: U.S. DOT, the National Highway Institute (NHI), the Federal Highway Administration (FHWA), the National Transit Institute (NTI), the Federal Transit Administration (FTA), the Institute of Transportation Engineers (ITE), and ITS America (ITSA). These courses are noted through the document with a checkmark (✓). A notation is also made to denote suggested reading materials that are available on the ITS EDL.
- * **Suggested general training and education** courses that have been identified as available through universities, vendors, professional associations, and/or available through other U.S. DOT programs. These courses are identified throughout the document with a star (*).
- ◇ **Recommendations for training courses that have not yet been identified** as available. These courses may exist, or may still need to be developed. These courses are identified by an unfilled diamond (◇). The listing of these courses also provide direction for PCB Program partners who are planning to develop new training and education.

The curricula are designed to be broad enough to include staff at both public sector highways and transit agencies and the private sector contractors. If courses have already been targeted for a highway or transit perspective, both are noted in the same box with an “or” to signify that either course will accomplish the same objective. When the public highway or transit role or private sector role differs enough, separate curriculum are provided.

ITS Curriculum — ITS Champions

Role Description: ITS Champions are also known as Advocates. They are individuals who promote the benefits of ITS to decision makers — both elected (legislators) and appointed (agency heads), to the internal staff at their agency and at other agencies, and to the public. In some respect, everyone involved in ITS needs to play this role. There are many documented examples of why this role is so important. To play this role effectively, it requires an in-depth awareness of ITS, and an ability to communicate effectively with political, executive, management and technical staff. Champions frequently have to spearhead organizational/institutional and legislative and policy changes to allow ITS deployments to occur.

The Champion role has been formalized within the ITS Commercial Vehicle Operations program, though the role exists informally within the ITS Metropolitan deployment program. It was noted throughout interviews that at leading-edge sites, there was a champion who was continually referred to as having promoted a guiding vision of ITS deployment. It was also noted that many project managers played the champion role within their agencies or on their projects. Across the interviews, this was described as a critical role.

Once the decision to deploy ITS has been made, the Champion plays an important role in building awareness and mainstreaming ITS. The typical background of a Champion is many years of experience in the transportation industry. This is important to be able to understand how all the various agencies, officials, and decision-makers play roles and have opportunities and limitations to their roles. Champions are charismatic, good communicators and negotiators, and usually politically well connected.

Functions and Responsibilities:

- Acts as a visionary who recognizes ITS as a tool for better operations and management of the transportation system, and meeting customer needs.
- Plays a role in building ITS awareness in other professionals who will make decisions.
- Is actively involved in planning and deploying ITS.
- Promotes and markets the benefits of ITS to other professionals; builds awareness in other transportation decision makers outside of the ITS deployment process in an effort to mainstream ITS concepts and terminology.
- Facilitates building a regional ITS vision among the various stakeholders.
- Helps identify roles that agencies and professionals will play in deployment, and provides information for deployment and operating decisions.

The following is a list of the recommended competencies to build the breadth required for an ITS Champion:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Technology Options (3) System Analysis and Design (4) National ITS Architecture ITS Standards Partnerships Marketing/Public Relations	Organizational/Institutional Change (2) Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Problem Solving Transportation Fundamentals

Recommended Core Training and Education for ITS Champions

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	Technology Options: Depends on the type of ITS project
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT) or ✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	ITS Topic Specific: Depends on project type
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	* Course in change management (business schools, universities, professional associations)

ITS Curriculum — Planners

Role Description: The role of the Planner exists both within transportation agencies and at Metropolitan Planning Organizations (MPO). Although these roles embody slightly differing functions and perspectives, the competencies are similar. Planners must be able to identify ITS opportunities, and evaluate them in the context of regional and agency goals and objectives, and determine the potential for their integration in capital improvement projects.

Planners at MPOs play an important role in integrating ITS projects into regional planning documents, thereby mainstreaming ITS into ongoing transportation planning. The most common ITS functions of the MPO planner role is to provide outreach and coordination with local transportation agencies to: demonstrate ITS and its benefits; promote the MPO as a forum for developing a regional ITS vision; sponsor multi-jurisdictional, multi-agency, and multi-discipline ITS committees; and serve as a link to policy makers and the private sector. **Planners at transportation agencies** play a role in integrating ITS projects into an agency's yearly transportation plans. ITS from this perspective is frequently mode-specific. Agency planners play a role in representing agency needs when building the regional ITS vision. They work with Project Managers to plan and design the agency's ITS projects and activities and they assist in ensuring that ITS projects have funding. They assist the agency with their familiarity with all applicable planning and environmental regulations.

Functions and Responsibilities:

- Understand funding mechanisms and processes, and be able to leverage financial resources in a strategic way for multiple agency benefit.
- Work cooperatively within a regional and political environment to build consensus on an ITS vision; help write Early Deployment Plans or ITS Plans.
- Compile ITS benefits; market ITS to senior decision makers and elected officials.
- Incorporate ITS projects into existing transportation planning documents, including Regional Transportation Plans, TIP, CMS, MIS, etc.
- Provide technical expertise in incorporating ITS into the planning process, GIS mapping, modeling, and forecasting.
- Help plan current and future expansion of operations.
- Research technology options and educate senior decision makers, elected officials, and project managers.
- Track ITS infrastructure already deployed.
- Assist in promoting multi-jurisdictional, multi-agency, multi-discipline, and project integration; help form partnerships among transportation agencies and between the public and private sector.
- Conduct studies on capacity, flow, and impact of ITS projects on surrounding jurisdictions.

The following is a list of the recommended competencies to build the breadth required for Planners:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Organizational/Institutional Change (2) Technology Options (3) Systems Analysis and Design (4) ITS Standards Marketing and Public Relations Project Evaluation Legislative and Policy Change ITS Legal Issues Operations	Managing Contractors (5) Financing (6) Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Data Management and Analysis (10) National ITS Architecture Project Management Partnerships Procurement Problem Solving Software and Hardware Operations

Recommended Core Training and Education for ITS Planners

Awareness Training

- | | |
|---|---|
| ✓ | ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or |
| ✓ | ITS in Transit (FTA) |
| ✓ | An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or |
| ✓ | The National ITS Architecture: An Introduction for FTA Senior Staff (FTA) |
| ✓ | Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) |
| ✓ | Deploying Integrated ITS — Rural (NHI) |
| ✓ | NTCIP and ITS Standards – What Do They Mean for You? (ITE) |
| | Technology Options: Depends on the type of ITS project |
| | For Transit Planners: |
| ✓ | Transit Performance Evaluation: Using Information-Based Strategies (NTI) |
| ✓ | ITS Telecommunications Overview (NHI) |
| * | Introductory course on the software development process (U.S. DOT, vendors and universities) |
| * | Introductory course on systems engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools) |
| * | Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools) |
| * | Course in marketing/public relations basics (universities, junior colleges) |
| ✓ | Recommended reading in ITS Institutional and Legal Issues (EDL) |
| ◇ | Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS. |
| ◇ | Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment. |
| * | ITS America's Legislative Affairs web-site. (http://www.itsa.org/legislative.html) |

Specialized Training

- | | |
|---|--|
| ✓ | Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT) |
| ✓ | ITS and the Transportation Planning Process (NHI) |
| ✓ | ITS Public/Private Partnerships (NHI) |
| ✓ | Shared Resources for Telecommunications (NHI) |
| ✓ | Planning the Integration of Transit and Traffic ITS Applications (NTI) |
| | For Transit Planners: |
| ✓ | Intelligent Transportation Systems for Transit: Solving Real Problems (NTI) and |
| ✓ | Reinventing Transit: Planning Information-Based Transit Services (NTI) |
| ✓ | Managing Systems Integrators (ITSA) |
| ✓ | Lessons Learned in ITS Procurement (NHI) |
| ✓ | ITS Telecommunications Analysis (NHI) |
| ✓ | ITS Software Acquisition (NHI) |
| ✓ | Use of CORSIM Computer Traffic Simulation Model (U.S. DOT) |
| ◇ | Other models as they become available |
| * | Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges) |
| * | Course in procurement and legal issues (U.S. DOT) |
| * | Courses on data analysis, management and databases (universities) |
| * | Course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations) |
| * | Courses on project management (U.S. DOT, universities and junior colleges) |
| * | Advanced course in negotiations (U.S. DOT, universities, professional associations) |
| * | Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors) |
| ◇ | Seminar on ITS Legal Issues. |

ITS Curriculum — Federal Field Staff

Role Description: The primary role of Federal Field Staff is to transfer information on ITS policy and ITS funding availability, and to provide technical assistance to state, regional, and local public sector transportation agencies. Both FHWA and FTA have designated individuals as ITS field specialists, many of whom have or are developing a technological background that will allow them to take a proactive advisory role when providing technical assistance to state, regional and local agency staff. FHWA has recently reorganized its nine regional offices into four Resource Centers with four ITS specialist positions at each center. FHWA Division Offices have a designated ITS staff member but it varies as to whether they function in full- or part-time capacity. The predominant difference between these two offices is that there appears to be a greater responsibility for Regional staff to coordinate and leverage experiences across the multiple deployments within a region, and a greater and more detailed focus by the Division office staff on State and local matters. FTA has designated one person in each of its ten Regional Offices to act as point-person for ITS questions and issues. This is in addition to other duties and frequently the FTA ITS Specialist functions on a part-time basis.

Functions and Responsibilities:

- Advise on the federal funding and the grants process as it applies to ITS projects; identify sources of funding.
- Work with state, regional and local transportation agency staff to identify local stakeholders, to form coalitions and private-sector partnerships, and establish peer-to-peer connections and mentoring opportunities; provide marketing support to engage non-traditional stakeholders as part of the conceptual design process.
- Have familiarity with state/local procurement requirements to help leverage local technology purchases; facilitate coordination of equipment and service needs of different agencies within a region as they move forward with deployments.
- Provide information for evaluating technology options including “tried-and-true” versus “leading-edge”; form relationships with vendors to provide information on costs, benefits, functionality; distribute cost/benefit evaluations of existing deployments; provide ITS training with best practices, successful approaches, and lessons learned in cooperation with local PCB partners such as universities and LTAP centers.
- Track regional, state and local deployment; track changes in project funding and scope.
- Participate in design of performance measures with transportation agencies for project testing and evaluation.
- Promote and market ITS to senior decision makers at state and local agencies, other federal transportation staff, local elected officials, and planners.
- Provide guidance on National ITS Architecture conformity and standards as part of the planning and design process for ITS projects.
- Develop/maintain working relationships among FHWA, FTA and OMC field offices to further project integration.
- Identify contractor’s expertise and provide assistance with qualifying them for state, regional, and local transportation agencies.
- Provide guidance and assistance on flexible funding, for example with FHWA and FTA funding transfers for joint projects.
- Extend audiences to include municipal and county transportation agencies; work in closer partnership with MPOs on promoting ITS and regional coordination among operating agencies.

The following competencies are recommended to build the breadth required for Federal Field Staff:

ITS Curriculum — Federal Field Staff (cont'd)

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Organizational/Institutional Change (2) Technology Options (3) Systems Analysis and Design (4) Financing (6) Writing/Communications (7) ITS Planning (8) Data Analysis and Management (10) Procurement Project Evaluation Operations	Building Coalitions (9) National ITS Architecture ITS Standards ITS Legal Issues A specialty in an ITS technology area such as software development, telecommunications, electronics, or systems engineering

Recommended Core Training and Education for FHWA Resource Center and Division Office ITS Specialists

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course on data analysis, management and databases (U.S. DOT, universities)
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS and Human Factors (JPO)
	* Introductory course on software and human factors (universities)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.
	◇ Workshop on using and writing ITS contracts and ITS specifications
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ Standard Training Modules (U.S. DOT)
	✓ Advanced Transportation Management Technology Workshop (FHWA)
	✓ Managing Systems Integrators (ITSA)
	✓ ITS Software Acquisition (NHI)
	✓ Shared Resources for Telecommunications (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)
	ITS Topic Specific:
	✓ Freeway Management Systems (NHI)
	✓ Incident and Emergency Management Systems (NHI)
	◇ Advanced Traveler Information Systems
	✓ Advanced Signal Control Systems (NHI)
	◇ Electronic Toll Collection Systems
	◇ Highway-Rail Crossings
	Advanced Technology Options:
	✓ Traffic Surveillance Systems (ITSA)
	✓ Freeway Traffic Operations (NHI)
	✓ Traffic Control Software and Signalization (NHI)
	✓ Computerized Traffic Signal Systems (NHI)
	✓ Advanced Traffic Signal Controllers (NHI)
	✓ HOV Facilities (NHI)
	✓ Advanced Sensors (ITSA)
	✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT)
	◇ Use of other models as they become available.
	* Advanced course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in procurement and legal issues (U.S. DOT)
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)
	◇ Seminar on ITS legal issues

Recommended Core Training and Education for FTA Regional Office ITS Specialists

Awareness Training	✓ ITS in Transit (FTA)
	✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course on data analysis, management and databases (U.S. DOT, universities)
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS and Human Factors (JPO)
	* Introductory course on software and human factors (universities)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.
	◇ Workshop on using and writing ITS contracts and ITS specifications
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Transit Management Course (FTA)
	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ Standard Training Modules (U.S. DOT)
	✓ Procuring New Technologies for Transit (NTI)
	✓ Managing Systems Integrators (ITSA)
	✓ ITS Software Acquisition (NHI)
	✓ Shared Resources for Telecommunications (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)
	ITS Topic Specific:
	✓ Advanced Public Transportation Systems (FTA)
	◇ Advanced Traveler Information Systems
	◇ Electronic Fare Payment Systems
	◇ Fleet Operations and Maintenance Systems
	Advanced Technology Options:
	✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI)
	✓ NTI Workshops on Advanced Technologies and Innovative Practices for Transit (NTI)
	✓ Geographic Information Systems: Transit Applications (NTI)
	✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT)
	◇ Use of other models as they become available.
	✓ Reinventing Transit: Planning Information -Based Transit Services (NTI)
	✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)
	* Advanced course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in procurement and legal issues (U.S. DOT)
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)
	◇ Seminar on ITS legal issues

ITS Curriculum — Project Managers

Role Description: The role of the Project Manager is a primary and significant role in ITS deployment. It requires one of the more comprehensive ranges of breadth and depth in ITS competencies.

ITS Project Managers activities frequently begin in their role at the planning and design stages of ITS projects and continue through the selection of staff and contractors, procurement, deployment and installation activities. Some Project Managers begin in the Champion role and are instrumental in the decision to deploy. Others begin once the decision to deploy has been made by senior Policy/Agency Managers. Once deployed and functional, Project Managers either transfer the working system's operations to an Operations Managers or become the Operations Manager.

ITS Project Managers must have a solid understanding of the transportation industry and the goals and functions of their agency. They must understand the problems that deployed systems are expected to resolve, and a detailed knowledge of how to apply ITS technologies. They are responsible for ensuring the deployment is carried out effectively and successfully through staff and contractors, which requires an understanding of how ITS fits into the on-going capital improvement construction process and existing operations.

Functions and Responsibilities:

- Manage ITS project deployments from design to operations, including:
 - Identify and involve all stakeholders in the system conceptualization and design, including other transportation agencies, non-traditional transportation agencies such as police, emergency and tow truck personnel, and other concerned groups.
 - Conduct/oversee user needs assessment as part of design process; understand data needs and flows.
 - Involve non-traditional but necessary staff and eventual users in the design and decision making, e.g., electronics technicians, operators, dispatchers, systems maintenance and support staff, and external agency team members.
 - Determine scope of deployment using analysis tools such as investment analysis, impact analysis, or cost/benefit analysis.
 - Apply National ITS Architecture and Standards to project design.
 - Participate in technology selection and procurement; help prepare RFPs; determine technology and systems specifications.
 - Provide project oversight of software development; work closely with developers.
 - Staff/contract for and schedule project deployment activities; coordinate work with ongoing construction activities.
 - Select and manage contractors, their schedules and delivery milestones.
 - Secure financing/funding, manage grants, prepare budgets, track expenses.
 - Manage installation and integration, including prototyping, testing and evaluation stages.
 - Conduct periodic evaluations throughout the project cycle and lead final project inspection, testing and evaluation.
 - Design and plan for operations staff, and support and maintenance staff.
- Ensure that the project is being deployed in tandem with other projects and assist with integration, including defining tests and performance measures that provide evidence of proper integration.
- Keep senior Policy/Agency Managers informed of progress and engage their assistance for institutional/organizational or legislative changes.
- Work with inter-jurisdictional coordinator to account for impact on surrounding jurisdictions.

The current Project Manager role differs markedly from the past. First, ITS planning, deployment and installation activities require different staff and staffing qualifications. Second, ITS projects tend to be less discrete than capital improvement projects; they tend to follow an iterative prototyping and testing process and frequently “bleed” into ongoing operations, thus requiring staff to work interdependently. In addition, ITS projects typically do not have clearly identified measures of performance that signify success.

The Project Manager plays a key role in helping to define those measures of performance. Each project requires a team of managers, engineers, analysts and technicians to envision what is feasible, what the requirements are, and what the results should be.

For the most part, the public and private sector Project Managers require similar competencies and backgrounds. Some of the more pronounced differences are:

- Private sector Project Managers are expected to have a more well-developed technical expertise in one or more of the competency areas of information technologies, systems integration and engineering, telecommunications, or software development. As such, the private sector Project Manager curriculum recommends advanced courses in these technical competencies under specialized training and introductory courses in institutional topics. However, it is assumed that most private sector Project Managers will have this technical expertise as part of their background.
- Public sector Project Managers are expected to have a more well-developed institutional expertise, including a comprehensive view of ITS deployment to coordinate with other ITS activities. As such, the public sector Project Manager curriculum recommends advanced courses in these institutional competencies under specialized training with introductory courses in the technical competencies. However, it is assumed that most public sector Project Managers will contain this institutional expertise as part of their background.
- Private sector Project Managers must ensure that they and their staff have an understanding of transportation fundamentals, such as vocabulary, traffic/transport engineering basics, and analysis of flow and capacity. They must be able to understand and meet contracted goals and objectives, and understand the statutory limitations of using public funds. Frequently, the private sector’s lack of transportation experience creates a communications problem with public sector Project Managers, as does the public sector’s lack of experience with information technologies, systems engineering, and software development.
- A contracted project manager is expected to have a solid level of commitment to the project to ensure that turnover does not hamper the deployment schedule, delivery milestones, or communications with the public sector client.

The following competencies are recommended to build the breadth and depth required for ITS Project Managers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness System Integration (1) Systems Analysis and Design (4) ITS Planning (8) Data Analysis and Management (10) National ITS Architecture ITS Standards Software Development Software and Hardware Operations ITS Human Factors ITS Legal Issues Marketing /Public Relations	Organizational/Institutional Change (2) Technology Options (3) Managing Contractors (5) Financing (6) Writing/Communications (7) Identifying Stakeholders/Building Coalitions (9) Project Management Procurement Project Evaluation Transportation Fundamentals Partnerships Legislative and Policy Change Problem Solving Operations

Recommended Core Training and Education for Public Sector State DOT and City/County DOT ITS Project Managers

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/)	Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)		✓ Standards Training Modules (U.S. DOT)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)		✓ Advanced Transportation Management Technology Workshop (FHWA)
	✓ Deploying Integrated ITS — Rural (NHI)		✓ Managing Systems Integrators (ITSA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)		✓ ITS Software Acquisition (NHI)
	✓ ITS and the Transportation Planning Process (NHI)		✓ ITS Telecommunications Analysis (NHI)
	✓ ITS Public/Private Partnerships (NHI)		✓ Shared Resources for Telecommunications (NHI)
	✓ ITS Telecommunications Overview (NHI)		✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)		ITS Topic Specific:
	* Introductory courses on the software development process (U.S. DOT, vendors and universities)		✓ Freeway Management Systems (NHI)
	* Introductory courses on software integration (vendors and universities)		✓ Incident and Emergency Management Systems (NHI)
	* Introductory courses on systems engineering, installing and integrating hardware and software (vendors, universities, technical/vocational schools)		◇ Advanced Traveler Information Systems
	* Introductory courses on data analysis, management and databases (U.S. DOT, universities)		✓ Advanced Signal Control Systems (NHI)
	* Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)		◇ Electronic Toll Collection Systems
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)		◇ Highway-Rail Crossings
	* Course in marketing/public relations basics (universities, junior colleges)		Advanced Technology Options:
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)		✓ Freeway Traffic Operations (NHI)
	✓ Recommended reading in ITS and Human Factors (JPO)		✓ Traffic Control Software and Signalization (NHI)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.		✓ Computerized Traffic Signal Systems (NHI)
	◇ Workshop on using and writing ITS contracts and ITS specifications		✓ Advanced Traffic Signal Controllers (NHI)
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.		✓ HOV Facilities (NHI)
			✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT)
			◇ Other models as they become available
			* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
			* Advanced course in negotiations (U.S. DOT, universities, professional associations)
			* Advanced course in procurement and legal issues (U.S. DOT)
			◇ Seminar in ITS Legal Issues
			* Course in project management and change management (business schools, universities, professional associations)
			✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)

Recommended Core Training and Education for Public Sector Transit ITS Project Managers

Awareness Training	✓ ITS FTA in Transit (FTA)
	✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	✓ ITS and the Transportation Planning Process (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Telecommunications Overview (NHI)
	✓ Lessons Learned in ITS Procurement (NHI)
	* Introductory courses on the software development process (U.S. DOT, vendors and universities)
	* Introductory courses on software integration (vendors and universities)
	* Introductory courses on systems engineering, installing and integrating hardware and software (vendors, universities, technical/vocational schools)
	* Introductory courses on data analysis, management and databases (U.S. DOT, universities)
	* Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	* Courses in public sector financial management: contracts, cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Course in marketing/public relations basics (universities, junior colleges)
	✓ Recommended reading in ITS and Institutional and Legal Issues (EDL)
	✓ Recommended reading in ITS and Human Factors (JPO)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment.
	◇ Workshop on using and writing ITS contracts and ITS specifications.
	◇ Case studies on how local areas worked with legislators and appointed officials to change policies to incorporate ITS.

Specialized Training	✓ Transit Management Course (FTA)
	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT)
	✓ Standards Training Modules (U.S. DOT)
	✓ Procuring New Technologies for Transit NTI)
	✓ Managing Systems Integrators (ITSA)
	✓ ITS Software Acquisition (NHI)
	✓ ITS Telecommunications Analysis (NHI)
	✓ Shared Resources for Telecommunications (NHI)
	✓ Planning the Integration of Transit and Traffic ITS
	✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI)
	✓ Transit Performance Evaluation: Using Information -Based Strategies (NTI)
	✓ Reinventing Transit: Planning Information -Based Transit Services (NTI)
	ITS Topic Specific: ✓ Advanced Public Transportation Systems (FTA, NTI) ◇ Electronic Fare Payment Systems ◇ Advanced Traveler Information Systems
	◇ Use of planning models as they become available
	Advanced Technology Options: ✓ NTI Workshops on Advanced Technologies and Innovative Practices for Transit (NTI) ✓ Geographic Information Systems: Transit Applications (NTI) Geographic Information Systems: Transit Applications (NTI)
	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in procurement and legal issues (U.S. DOT)
	◇ Seminar in ITS Legal Issues
	* Course in project management and change management (business schools, universities, professional associations)
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)

Recommended Core Training and Education for Private Sector ITS Project Managers

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ITS in Transit (FTA) 	Specialized Training	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA) 		<ul style="list-style-type: none"> ✓ Standards Training Modules (U.S. DOT)
	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI) 		<ul style="list-style-type: none"> ✓ ITS Software Acquisition (NHI)
	<ul style="list-style-type: none"> ✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE) 		<ul style="list-style-type: none"> ✓ ITS Telecommunications Analysis (NHI)
	<ul style="list-style-type: none"> ✓ ITS and the Transportation Planning Process (NHI) 		<ul style="list-style-type: none"> ✓ Shared Resources for Telecommunications (NHI)
	<ul style="list-style-type: none"> ✓ ITS Public/Private Partnerships (NHI) 		ITS Topic Specific: Depends on project type
	<ul style="list-style-type: none"> ✓ ITS Telecommunications Overview (NHI) 		Advanced Technology Options: Depends on project type
	<ul style="list-style-type: none"> * Courses on project management (U.S. DOT, universities and junior colleges) 		<ul style="list-style-type: none"> * Advanced course in negotiations (U.S. DOT, universities, professional associations)
	<ul style="list-style-type: none"> * Course in marketing/public relations basics (universities, junior colleges) 		<ul style="list-style-type: none"> * Advanced course in procurement and legal issues (U.S. DOT)
	<ul style="list-style-type: none"> ✓ Recommended reading in ITS Institutional and Legal Issues (EDL) 		<ul style="list-style-type: none"> * Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	<ul style="list-style-type: none"> ✓ Recommended reading in ITS and Human Factors 		<ul style="list-style-type: none"> ✓ Use of the CORSIM Computer Traffic Simulation Model (U.S. DOT) ◇ Other planning models as they become available
	<ul style="list-style-type: none"> ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment 		<ul style="list-style-type: none"> * Courses on the software development process (U.S. DOT, vendors and universities)
			<ul style="list-style-type: none"> * Advanced courses on software integration (vendors and universities)
			<ul style="list-style-type: none"> * Advanced courses on systems engineering, installing and integrating hardware and software (vendors, universities, technical/

ITS Curriculum — Software Developers

Role Description: The role of Software Developer within ITS deployment is emerging as one of the more critical ones since most ITS is dependent upon software for a wide variety of functions.

Some agencies will employ software developers to develop proprietary programs. Frequently, however, software development is not perceived to be a core competency in a public sector agency. On bigger and more complex projects, the agencies contract with a consultant or vendor who offers a mix of services, including software development.

Typical backgrounds of software developers are in computers and software engineering. It is critical for the software developer to have a good understanding of transportation fundamentals and mode-specific applications in order to develop software that is relevant to the agency. For instance, signal timing requires more than just LAN/WAN connections; it requires understanding how to time an intersection and the compounded effects of timed intersections on each other in terms of traffic flow. Again, the ability to work closely with the client aids in this understanding. They must also have in-depth knowledge of system analysis and design, the various technologies that will comprise the system, software and hardware operations, systems integration process and schedule, and data flow, analysis, and management issues.

Functions and Responsibilities:

- Understand and design software to meet the needs of the system characteristics, such as existing compatibility, expandability, and maintenance issues.
- Understand and design software to meet the needs of end users.
- Write or adapt off-the-shelf/existing software to collect transportation system information for decision-making in real-time.
- Manage the software development process to meet the contract agency's milestones.
- Communicate frequently with public-sector project manager regarding the development process, schedule, software's abilities, and compatibility issues with hardware, other software, and other systems.
- Work with systems designers to adapt software to meet the needs of the whole system.
- Participate in defining performance measures for acceptance testing of software and system.

The following is a list of the recommended competencies to build the depth required for Software Developers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Writing/Communications (7) Project Management ITS Legal Issues Project Evaluation Operations Transportation Fundamentals	Systems Integration (1) System Analysis and Design (4) Database Management and Analysis (10) National ITS Architecture ITS Standards ITS Human Factors Software Development Software and Hardware Operations Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Software Developers

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ITS in Transit (FTA)	Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT) or
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)		✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)		✓ Standards Training Modules (U.S. DOT)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)		✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Deploying Integrated ITS — Rural (NHI)		✓ ITS Telecommunications Analysis (NHI)
	✓ ITS Telecommunications Overview (NHI)		Technology Options:
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)		✓ Advanced Transportation Management Technology Workshop (FHWA) or
	* Course in procurement and legal issues (U.S. DOT)		✓ Procuring New Technologies for Transit (NTI) and Geographic Information Systems: Transit Applications (NTI)
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)		* Advanced courses on software integration and performance testing (vendors and universities)
	* Courses on project management (U.S. DOT, universities and junior colleges)		* Courses on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical schools)
	✓ Recommended reading in ITS Institutional and Legal Issues		* Advanced courses on data analysis, management and databases (universities)
	✓ Recommended reading in ITS and Human Factors (JPO)		* Courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefits analysis after deployment.		
	✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)		

ITS Curriculum — System Designers and Integrators

Role Description: Systems Designers and Integrators perform critical roles in ITS deployment. These roles require a broad technical understanding of ITS to be able to envision and connect hardware and technologies together and apply software applications to form working systems. It also means being able to integrate older “legacy” systems into operations. These roles also require a specific knowledge of how to design, install, integrate, operate, and test the technologies and systems being deployed. Knowledge of the fundamental principles of different types of engineering sciences is essential to these roles including:

- Electrical engineering;
- Telecommunications engineering;
- Systems engineering including systems architecture and standards;
- Software development including how software integrates with various ITS technologies;
- Hardware and wiring requirements;
- Relational databases and data sharing/data flow requirements.

Systems designers and integrators play complementary but different roles in ITS. Whereas one envisions and puts on paper the system to come, the other does hands-on application to make it happen. However, the competency set required is similar.

Functions and Responsibilities:

- Analyze existing infrastructure.
- Conduct user needs assessment; map out data flows to users.
- Design a system; ensure compatibility with existing infrastructure.
- Analyze technology options and participate in the decision making for the various devices, computers, and software applications; provide designs for and connect devices through telecommunication wiring or wireless media.
- Install ITS technologies, ensuring functionality and quality control; bring together components to function as one system.
- Integrate technologies into existing system.
- Participate in the design of performance measures; participate in the testing and evaluation throughout project and at end (part of the testing is ensuring that the right data is flowing in the right direction without corruption).
- Train operators, maintenance and support staff on system functions, operations, maintenance and management.; ensure maintenance procedures and operations manuals are available.

Systems designers and integrators are predominantly employed in the private sector, although some professionals are employed by public sector transportation agencies. The competencies are similar, with the caveat that private sector designers and integrators must have a background in basic transportation fundamentals in order to understand why the transportation agency wants the system to function as it does, and to ensure that the system delivers the functions needed. The following is a list of the recommended competencies to build the breadth and depth required for Systems Designers and Integrators:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Writing/Communications (7) ITS Legal Issues Project Management Procurement Operations, especially agency procedures Transportation Fundamentals	Systems Integration (1) Organizational/Institutional Change (2) Technology Options (3) System Analysis and Design (4) Data Analysis and Management (10) National ITS Architecture ITS Standards Software Development ITS Human Factors Software and Hardware Operations Problem Solving Project Evaluation

Recommended Core Training and Education for Systems Designers and Integrators

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or	Specialized Training	✓ Using the National ITS Architecture for Deployment for the Public Sector (U.S. DOT) or
	✓ ITS in Transit (FTA)		✓ Using the National ITS Architecture for Deployment for the Private Sector (U.S. DOT)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT)		✓ Standards Training Modules (U.S. DOT)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)		Advanced Technology Options: Depends on the type of ITS project
	✓ Deploying Integrated ITS — Rural (NHI)		✓ ITS Telecommunications Analysis (NHI)
	✓ ITS Telecommunications Overview (NHI)		✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT)		✓ Lessons Learned in ITS Procurement (NHI)
	Technology Options:		ITS Topic Specific: Depends on project type
	✓ Advanced Transportation Management Technology Workshop (FHWA) or		* Advanced courses on the software development process (U.S. DOT, vendors and universities)
	✓ Procuring New Technologies for Transit (NTI)		* Advanced courses on software integration and performance testing (vendors and universities)
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)		* Advanced courses on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools)
	* Courses on project management (U.S. DOT, universities and junior colleges)		* Advanced courses on data analysis, management and databases (universities)
	* Course in procurement and legal issues (U.S. DOT)		* Advanced courses on operating and maintaining networks and software, and inspections and testing of systems (vendors, technical/vocational schools)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)		* Advanced courses on software and human factors (universities)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)		✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)
	✓ Recommended reading in ITS and Human Factors (EDL)		* Course in project management and change management (business schools, universities)
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment		
	◇ Workshop on using and writing ITS specifications		

ITS Curriculum — Operators

Role Description: Successful implementation of an ITS project results in more efficient operations of the existing transportation system. Operators are at the heart of the system, working at Transportation Management Centers at State and City/County DOTs or at Transit Operations Centers or Traveler Information Centers. They used to be predominantly public sector employees, but the recent wave of privatization has brought private sector firms in to manage these centers.

The role of the **operator within a management/operations center** is to ensure the smooth operation of the system, identify problems, and initiate and follow-through with responses. Operators use computers and video to monitor capacity and flow, collect data and make decisions in real-time for better management of the transportation system.

Traveler information center operators play a more limited role in delivering system information to the public. They respond to traveler's phone inquiries and maintain internet site and kiosk information. They manage the advanced traveler information systems which may include applications for cell phones, kiosks, variable message signs, the internet, etc.

Recent deployment experiences have revealed that operators should be included in the systems analysis and design process. Designers must consider what information they need, how the information is used, and how the operator is physically set-up to function in his/her space.

Operators require knowledge of basic transportation fundamentals and terminology, with extensive knowledge of the local transportation network and incident and emergency management procedures especially hazardous material diagnostics. These individuals must have good communication and problem-solving skills, and must be able to react quickly and rationally to an incident. Multi-tasking capabilities are also important for anyone performing one of these roles. Presentation skills are particularly important when interacting with the media.

Functions and Responsibilities:

- Monitor system capacity and flow.
- Help to make real-time decisions and communicate those to the public.
- Help to diagnose incidents and provide coordinated quick-response to traffic and incident problems by dispatching appropriate assistance.
- Broadcast status information; possibly interact with media.
- Be well-versed in agency policies and procedures for disseminating information
- Be able to utilize ITS technologies such as variable message signs for broadcast to and management of the traveling public.
- Identify and report/repair minor communications/computing system problems.
- Understand the system well enough technically to troubleshoot minor problems with hardware/equipment functionality.
- Be able to clearly communicate with the information system support professionals (I/S or MIS or System Maintenance and Support Technicians) about minor and major problems.
- For transit and traveler information operators, provide automated trip planning services; determine call needs; offer suggestions for travel options.

The following is a list of the recommended competencies to build the breadth and depth required for Operators:

ITS Curriculum — Operators (cont'd)

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) Technology Options (3) Data Analysis and Management (10) Marketing/Public Relations Systems Support and Maintenance Operations, especially agency procedures	Writing/Communications (7) Software and Hardware Operations Transportation Fundamentals ITS Topics: <ul style="list-style-type: none"> • Incident and Emergency Management Systems • Hazardous Materials • Freeway Management Systems • Advanced Public Transportation Systems Problem Solving

Recommended Core Training and Education for Operators

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	Technology Options: Depends on the type of ITS project
	* Introductory courses on data analysis, management and databases (U.S. DOT, universities)

Specialized Training	* Course in the basics of public relations and public speaking (universities, junior colleges)
	* Courses on operating and minor troubleshooting of networks, hardware, and software (vendors, technical/vocational schools)
	* Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	* Advanced courses/certification in transportation operations (universities – e.g., CalPoly course, technical/vocational schools)
ITS Topic Specific: Depends on type of management/operations/information center	

ITS Curriculum — Dispatchers

Role Description: Dispatchers work closely with operators to manage fleets of vehicles that are critical in responding to: incidents, demand, or other problems. Dispatchers are predominantly public sector employees and are a mix of traditional and non-traditional transportation agency staff who work on-site at management/operations centers as:

- Transit agency employees to dispatch buses.
- State and City/County DOT agency employees to dispatch tow trucks, snow plows, and other vehicles.
- Public safety employees to dispatch police, fire and emergency vehicles.
- Contractors hired as part of the operations staff at highway, traffic or transit agencies.

Dispatchers know where their vehicles are through vehicle location devices that are part of the system. Dispatchers help operators make decisions about the use of a vehicle and driver in mitigating a transportation system problem, such as an incident or increase in demand. They then make decisions as to how to get the vehicle in use or to a particular destination as quickly and safely as possible. Typically, dispatchers have risen through the ranks of highway and city patrol officers and others who have "road experience" and are familiar with the transportation network.

More so than operators, dispatchers are frequently engaged in cross-agency cooperation and team work. They must have an overall sense of the goal of operations, and be clear on the various agency operations procedures, and the potential jurisdictional issues and legal issues that might arise.

Functions and Responsibilities:

- Manage location devices to track fleet.
- Dispatch and scheduling procedures.
- Determine caller needs.
- Provide coordinated quick-response to traffic and incident problems by dispatching appropriate assistance.
- Identify and report/repair system problems.

The following is a list of the recommended competencies to build the breadth and depth required for Dispatchers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) and/or agency procedures Technology Options (3) Data Analysis and Management (10) ITS Legal Issues Operations	Transportation Fundamentals Software and Hardware Operations Problem Solving ITS Specific Topics: <ul style="list-style-type: none">• Incident Management• Hazardous Materials• Diagnostics and Procedures• Vehicle Diagnostics

Recommended Core Training and Education for Dispatchers

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	Technology Options: Depends on the type of ITS project
	<ul style="list-style-type: none"> * Courses on data analysis, management and databases (U.S. DOT, universities)
	<ul style="list-style-type: none"> ◇ Seminar on ITS Legal Issues

Specialized Training	<ul style="list-style-type: none"> * Courses on operating and minor troubleshooting of networks, hardware, and software (vendors, technical/vocational schools)
	<ul style="list-style-type: none"> * Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	<ul style="list-style-type: none"> * Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	<ul style="list-style-type: none"> * Advanced courses/certification in transportation operations (universities – e.g., the TMC Operators course at the California Polytechnic Institute, technical/vocational schools)
	<p>ITS Topic Specific: Depends on type of management/operations/information center but should include:</p> <ul style="list-style-type: none"> ✓ Incident Management (NHI) ◇ Hazardous Materials ◇ Vehicle Diagnostics and Procedures

ITS Curriculum — Drivers

Role Description: “Drivers” include tow truck operators, law enforcement, emergency personnel, and transit drivers, among others. Drivers work closely with operators and dispatchers to respond to requests for assistance in emergencies or for increased demand. They are human probes on the roadway and report information and observations back to the management/operations center to supplement the data from the devices. They are also recipients of fully synthesized information from the center. Thus they must have good verbal communication skills. They also must be trained on the devices located on their vehicles for proper operations, downloading data, understanding how their data affects the system’s management, and how the devices support them doing their job.

Functions and Responsibilities:

- Report information and observations back to the management/operations center to supplement the data from the vehicle devices or the system network.
- Respond to dispatcher requests.
- Follow agency/company procedures in incident and emergency management.
- Download data at shift’s end.

The following is a list of the recommended competencies to build the breadth and depth required for Drivers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Transportation Fundamentals Data Analysis and Management (10) Operations	Technology Options (3) , especially training on ITS devices ITS Topics: <ul style="list-style-type: none">• Incident and Emergency Management• Hazardous Materials Management

Recommended Core Training and Education for Drivers

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	<ul style="list-style-type: none"> * Courses on data analysis, management and databases (U.S. DOT, universities)
	<ul style="list-style-type: none"> * Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)

Specialized Training	<ul style="list-style-type: none"> * Training on ITS devices on vehicles (vendors)
	<p>ITS Topic Specific: Depends on type of management/operations/information center but should include:</p> <ul style="list-style-type: none"> ✓ Incident and Emergency Management (NHI) ◇ Hazardous Materials Management ◇ Vehicle Diagnostics

ITS Curriculum — Electronics Inspection and Maintenance Technicians

Role Description: Electronics inspection and maintenance technicians have traditionally maintained the electronics installed by contractors at the agency and in the field. Typically, contractors have trained public sector electronics technicians on the operation and the maintenance of the devices. Technicians are responsible for replacing and repairing devices that do not work and performing preventive maintenance on the technologies. With the advent of ITS, these individuals must be a greater part of the system design effort to ensure smooth integration of the ITS project into existing maintenance activities. This includes an involvement in the upfront stages of ITS planning, design and procurement where these technicians can provide important insight into:

- The technology selection process to ensure compatibility with existing devices and to plan for the inventory impact.
- Physical placement of the devices on the infrastructure to ensure ease of access, cost effective procedures of installation, and safety when making future repairs or expansions.
- The human factors of placing the equipment within the cabinets to ensure safety.

Functions and Responsibilities:

- Test and inspect construction and integration work, especially fiber optic splices and connections.
- Work with systems designers on technology selection and physical placement.
- Evaluate project operations.
- Troubleshoot problems in the field, including repairing and replacing ITS technologies (electronic devices) and hardware.
- Troubleshoot hardware and software problems.
- Install new equipment and integrate with existing systems.
- Supervise and inspect contractor installations.
- Maintain and repair traffic signal control systems.
- Work with systems designers to establish a proper cabinet and equipment placement on the infrastructure, as the human factors and safety considerations are particularly important for future repair and expansion.

The following competencies are recommended to build the ITS understanding required for electronics inspection and maintenance technicians:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Organizational/Institutional Change (2) Systems Analysis and Design (4) Managing Contractors (5) Writing/Communications (7) National ITS Architecture ITS Standards ITS Human Factors Project Evaluation Transportation Fundamentals	Technology Options (3) Software and Hardware Options Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Electronics Inspection and Maintenance Technicians

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (U.S. DOT)
	✓ Lessons Learned in ITS Procurement (NHI)
	* Courses on software integration (vendors and universities)
	* Introductory courses on systems engineering, installing and integrating hardware and software, telecommunications engineering, electrical engineering (vendors, universities, technical/vocational schools)
	* Introductory course in verbal and written communications, presentations (universities, junior colleges)
	✓ Recommended reading in ITS and Human Factors (EDL)
	◇ Seminar on ITS Legal Issues
	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment
	◇ Workshop on using and writing ITS specifications
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)

Specialized Training	✓ Managing Systems Integrators (ITSA)
	✓ Standards Training Modules (U.S. DOT)
	Advanced Technology Options: Depends on the type of ITS project
	Advanced Technology Options: Depends on project type
	* Advanced courses on networks (vendors, universities, technical/vocational schools)
	* Advanced courses on repairing and maintaining electronics (vendors, universities, technical/vocational schools)

ITS Curriculum — Operations Managers/Supervisors

Role Description: The Operations Manager/Supervisor is responsible for running an operations center, referred to as Transportation Management Centers (TMCs) or Operations Centers (TOCs) depending on agency terminology. He/she determines operating procedures regarding signal controls and VMS message broadcasting based on congestion and incident data. This requires establishing decision-making procedures in cooperation with police, emergency staff, and other agency dispatchers. In the transit industry, this person actually manages the operation. For instance, the day-to-day transportation functions of a bus system are their responsibility.

These individuals must be adept at managing a rotating staff. They must have a strong understanding of the mission and the operational protocols of the TMC. In addition, they must be knowledgeable about the software, hardware, and operating systems, and experienced at troubleshooting technical problems and with incident management protocols. Most people at this level have come up through the ranks. They possess an in-depth knowledge of the existing system and its complexities and a strong transportation engineering background. Some of the interviewees had a traffic broadcasting background. Computer skills varied by agency.

Operations Managers/Supervisors step in as deployment activities turn to actual operations activities. They work closely with Project Managers to ensure that the system they inherit performs as needed, and continue to work with systems integrators and maintenance technicians to resolve operational needs.

Functions and Responsibilities:

- Managers:
 - Responsible for TMC Operations
 - Determine operating procedures including signals and VMS messages based on congestion and incident data.
 - Establish decision making procedures in cooperation with police, emergency staff, and other agency dispatchers.
 - Responsible for staffing; writing job descriptions; hiring and training in-house and contracted staff; negotiating staff conflicts.
 - Responsible for TMC budget development and monitoring.
 - Interacts with media on both marketing and incident reporting to the general public.
- Supervisors:
 - Manage staff and schedule shifts.
 - Provide on-the-job staff training.
 - Resolve day-to-day staff and equipment problems.

The following is a list of the recommended competencies to build the depth and breadth required for Operations Managers and Supervisors:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Data Analysis and Management (10) ITS Standards Partnerships Marketing/Public Relations Project Management Project Evaluation ITS Human Factors	Organizational/Institutional Change (2) Technology Options (3) , especially training on ITS devices Managing Contractors (5) Financing (6) , especially budgeting and accounting procedures Software and Hardware Operations Systems Support and Maintenance Problem Solving Operations

Recommended Core Training and Education for Operations Managers and Supervisors

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	<ul style="list-style-type: none"> ✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	<ul style="list-style-type: none"> ✓ ITS and the Transportation Planning Process (NHI)
	<ul style="list-style-type: none"> ✓ ITS Public/Private Partnerships (NHI)
	If Transit Operations Manager: <ul style="list-style-type: none"> ✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI) ✓ Reinventing Transit: Planning Information - Based Transit Services (NTI)
	<ul style="list-style-type: none"> * Courses on project management (U.S. DOT, universities and junior colleges)
	<ul style="list-style-type: none"> * Course in public relations and public speaking (universities, junior colleges)
	<ul style="list-style-type: none"> * Courses on data analysis, management and databases (U.S. DOT, universities)
	<ul style="list-style-type: none"> ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment
	<ul style="list-style-type: none"> * Recommended reading on ITS and Human Factors (JPO)

Specialized Training	Technology Options: <ul style="list-style-type: none"> ✓ Advanced Transportation Management Technology Workshop (FHWA) or ✓ Procuring New Technologies for Transit (NTI)
	Advanced Technology Options: Depends on project type
	If Transit Operations Manager: <ul style="list-style-type: none"> ✓ NTI Workshops on Advanced Technologies and Innovative Practices for Transit (NTI) and ✓ Geographic Information Systems: Transit Applications (NTI)
	<ul style="list-style-type: none"> ✓ Managing Systems Integrators (ITSA)
	<ul style="list-style-type: none"> * Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	<ul style="list-style-type: none"> * Course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	<ul style="list-style-type: none"> * Courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	<ul style="list-style-type: none"> * Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	<ul style="list-style-type: none"> * Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	<ul style="list-style-type: none"> * Course in change management (business schools, universities, professional associations)

ITS Curriculum — Business Analyst

Role Description: The position of Business Analyst is becoming increasingly important in ITS for numerous reasons. First, given the high costs of technology deployments, solid investment analysis must be done to “market” ITS projects to high-level decision-makers. In addition, innovative financing methods are increasingly being used. Partnership agreements require analysis of financial and investment risk. Decisions on technologies require cost/benefit analysis. Interviewees stressed the growing need to have this role filled within agencies and on projects.

Functions and Responsibilities:

- Provide suggestions for making project and investment decisions.
- Perform cost/benefit and other related analyses on technologies and systems.
- Suggest organizational changes for project deployment.
- Help in forming financial partnerships for projects such as smart card partnerships.
- Supply input on project evaluation.

The following is a list of the recommended competencies to build the depth and breadth required for Business Analysts:

Awareness Level Competency Recommendations	Specialized Level Competency Recommendations
ITS Awareness Technology Options (3) Writing/Communications (7) Data Analysis and Management (10) ITS Legal Issues Legislative and Policy Change Procurement Software and Hardware Operations Transportation Fundamentals	Organizational/Institutional Change (2) Financing (6) Partnerships Project Evaluation

Recommended Core Training and Education for Business Analysts

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	Technology Options: Depends on the type of ITS project
	* Course in writing business plans/project plans, writing specifications (U.S. DOT, universities, professional associations)
	◇ Workshop on using and writing ITS contracts and ITS specifications
	* Courses on data analysis, management and databases (U.S. DOT, universities)
	◇ Seminar on ITS Legal Issues
	✓ Lessons Learned in ITS Procurement (NHI)
	* Course in procurement and legal issues (U.S. DOT) ✓ Procuring New Technologies for Transit (NTI)
	* Courses on software applications such as word processing, spreadsheets, databases or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	◇ Case studies from agencies who worked with their state, regional and local legislators and appointed officials to change policies to incorporate ITS
	* Course in change management (business schools, universities, professional associations)

Specialized Training	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	* Advanced courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	✓ Shared Resources for Telecommunications (NHI)
	✓ ITS Software Acquisition (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	◇ Workshop on ITS project evaluation, setting performance measures, and cost/benefit analysis after deployment
	✓ Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (EDL)

ITS Curriculum — Data(base) Manager/Analyst

Role Description: Data(base) Managers/Analysts play a critical role in ITS operations and management given the breadth of data generated from advanced technologies. The proliferation of data collection devices, the need for public agencies to continually deliver “more for less”, and the advances in database technology create a situation where so much information is available that it can tend to be overwhelming. The essence of any ITS device is the data that it produces, and the value of the system is closely related to how the data is used. Agencies need to apply the information they have gathered in ways that will improve their transportation systems, and better inform their decision-making processes. This is where the role of Data Managers and Analysts becomes critical.

Functions and Responsibilities:

- Help define data standards to enable cross agency data sharing; help define and support data sharing across agencies.
- Design, maintain and manage relational databases for decision making.
- Turn raw data into usable information.
- Design report formats and run queries (SQL) and reports; perform analysis as requested, generate useful and timely reports, coordinate data sharing with other agencies and monitor data security and storage.
- Analyze data for patterns and trends; interpret data and use it for problem solving and decisionmaking.
- Report and disseminate data throughout organization; disseminate data results to other agencies.
- Responsible for overall quality and integrity of data generated and used by the system.
- Keep project management well-informed of potential uses of data for planning, project evaluation and other purposes.
- Assist with studies: for example in highway agencies, speed and volume studies; in transit agencies, performance reports that support the scheduling, fleet management, and service planning staff functions.
- Ensure databases comply with standard communications protocols and ITS standards.

The following is a list of the recommended competencies to build the depth and breadth required for Data(base) Managers and Analysts:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) Technology Options (3) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) National ITS Architecture ITS Standards ITS Human Factors, especially human interface design Transportation Fundamentals Operations	Systems Integration (1) Systems Analysis and Design (4) Data Analysis and Management (10) Software Development Software and Hardware Operations Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Data(base) Managers and Analysts

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ ITS Telecommunications Overview (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	✓ ITS and the Transportation Planning Process (NHI)
	If a Transit Manager: ✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI) and ✓ Reinventing Transit: Planning Information - Based Transit Services (NTI) and ✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)
	✓ Use of the CORSIM Computer Traffic Simulation Model (NHI) ◇ Other models as they become available
	* Course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	✓ Recommended reading on ITS and Human Factors (JPO)
	* Introductory course on software and human factors

Specialized Training	✓ Using the National ITS Architecture for Deployment—Public Sector (U.S. DOT)
	✓ Standards Training Modules (U.S. DOT)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ ITS Telecommunications Analysis (NHI)
	* Introductory course on the software development process (U.S. DOT, vendors and universities)
	* Course on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools)
	* Advanced courses on data analysis management and databases (universities)
	* Advanced courses on software applications such as basic language, databases, relational databases, queries and reports, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)

ITS Curriculum — Contract Specialists

Role Description: Like traditional transportation capital improvement projects, ITS requires the use of contracts to procure necessary equipment and services. However, ITS equipment and services have proven to be unique to many procurement divisions in transportation agencies. Therefore, ITS contracts require different clauses and procurement methods. It also requires the ability and flexibility to contract for expertise that tends not to have a discrete time period or deliverable date.

Contract Specialists in ITS are those professionals who recognize all of these nuances, and know the agency's and state's legislative limitations well enough to figure out how to procure what they need for their ITS deployment. The contract specialist role is typically performed as part of the project manager's role, working in conjunction with their agency legal staff or, in some cases, even their state's attorney generals. However, there are agencies who employ acquisitions staff who will need to develop these competencies in order to provide effective contracts for ITS project contractors and technology purchases.

Functions and Responsibilities:

- Help prepare contracts.
- Incorporate clauses in contracts to address ITS issues including software ownership and Intellectual Property Rights.
- Select the most appropriate contract type for deployment.
- Help shape contract language based on the RFP and the negotiated agreement; help ensure that the final contract reflects the planned scope of work, not simply the RFP wording.
- Help ensure that value-added services are reflected in contracts, if appropriate, e.g., vendor training on purchased equipment, ongoing maintenance, provision of operations and maintenance procedures manuals, etc.

The following is a list of the recommended competencies to build the depth and breadth required for Contract Specialists:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Financing (6) Partnerships Legislative and Policy Change Software Development Software and Hardware Operations	Writing/Communications (7) Procurement ITS Legal Issues

Recommended Core Training and Education for Contract Specialists

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Telecommunications Overview (NHI)
	* Courses in public sector financial management: Cost/benefit analysis, Risk analysis, Investment analysis, Budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Introductory course on the software development process, software integration into a system, and performance measures for testing (U.S. DOT, vendors, universities)
	* Introductory course on operating and maintaining networks and software (vendors, technical/vocational schools)
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	* ITS America's Legislative Affairs web site: http://www.itsa.org/legislative.html

Specialized Training	✓ Lessons Learned in ITS Procurement (NHI)
	✓ ITS Software Acquisition (NHI)
	✓ Shared Resources for Telecommunications (NHI) (as needed — depending on the type of project)
	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Course in procurement and legal issues (U.S. DOT)
	◇ Advanced workshop course in writing contracts for ITS procurements
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)

ITS Curriculum — Legal Staff

Role Description: Agency legal staffs are primarily involved in the preparation, review and execution of contracts, as well as an assessment of the project's risks and liabilities. Their up-front, as well as on-going involvement in understanding the project manager's role, and in the process of writing the RFPs and contracts for ITS can prove very valuable. Legal staff are responsible for helping project managers and agency executives understand the limits of the state's laws for using contracts as well as in approaching the state legislature for changes in law and policy. When legal staff were not aware of ITS issues, their review of the related contracts delayed the deployment process and they became obstacles to deployment.

Another role for legal staff in ITS is for negotiating such new situations as telecommunications leases or shared resource agreements. Their analysis of the potential liability that could arise from ITS deployments, and their assessment of the risk that it poses to the transportation agency can be invaluable, for instance, law suits that arise from providing route guidance in the instance of an accident or, privacy issues that arise from video enforcement.

Their expertise in the legal issues can come from involvement in an ITS deployment, learning from ITS America's legal issues committee, or even taking a class in specific areas that ITS introduces, such as software development law or intellectual property rights law. Their law degree gives them the foundation to understand state laws and agency authority limitations, as well as for understanding contracting and the various types available.

Functions and Responsibilities:

- Review project specifications for liability issues in design.
- Review contracts for clauses and language supportive of ITS.

The following is a list of the recommended competencies to build the depth and breadth required for Legal Staff:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Financing (6) Software Development Transportation Fundamentals	Writing/Communications (7) ITS Legal Issues Legislative and Policy Change Partnerships Procurement

Recommended Core Training and Education for Legal Staff

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ ITS Telecommunications Overview (NHI)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	* Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Courses on the software development process (U.S. DOT, vendors, universities)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
Specialized Training	✓ Lessons Learned in ITS Procurement (NHI)
	✓ ITS Software Acquisition (NHI)
	✓ ITS Public/Private Partnerships (NHI)
	✓ Shared Resources for Telecommunications (NHI)
	* Course in procurement and legal issues (U.S. DOT)
	* Advanced course in writing business plans/ project plans, writing specifications, contracts (U.S. DOT, universities, professional associations)
	◇ Advanced workshop course in using and writing ITS contracts for ITS procurements
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	* Course in change management (business schools, universities)

ITS Curriculum — Marketing/Public Relations Staff

Role Description: This role has become important given the need to publicize ITS to politicians, transportation officials and the general public. Marketing/Public Relations staff at public transportation agencies summarize ITS benefits and “lessons learned” in presentations targeted at high-level decision-makers, elected and appointed officials and the general public.

These individuals must have excellent communication skills. They must know how to communicate the benefits of ITS projects to high level decision-makers, elected and appointed officials, the general public and the press. This involves segmenting audiences and tailoring presentations to create "buy in". They can also be instrumental in promoting ITS internally, changing organizational behavior to a positive acceptance of ITS projects.

Functions and Responsibilities:

- Summarize ITS benefits and “lessons learned” in presentations targeted at high level decision makers and officials.
- Disseminate educational and promotional material to the public to enhance informed decision making by travelers.
- Segment, understand, and provide outreach to audiences that need to know about ITS.
- Inform travelers and other agencies about new ITS systems and their benefits; demonstrate benefits.

The following is a list of the recommended competencies to build the depth and breadth required for Marketing / Public Relations Staff:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Organizational/Institutional Change (2) Technology Options (3) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Transportation Fundamentals National ITS Architecture	Writing/Communications (7) Marketing/Public Relations

Recommended Core Training and Education for Marketing / Public Relations Staff

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for FTA Senior Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS

Specialized Training	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in presentations and negotiations (U.S. DOT, universities, professional associations)
	* Advanced courses in marketing and public relations (universities, junior colleges)
	✓ Recommended reading: Marketing ITS Infrastructure in the Public Interest (EDL)

ITS Curriculum — Human Resources Staff

Role Description: Human Resources staff works closely with project managers to staff ITS teams. These individuals must know how to write job descriptions or adapt existing ones to include technical skills and responsibilities. They must also have a good understanding of salary scales to hire and retain staff needed for an ITS project.

Human Resource staff will see job classifications, descriptions and staff hiring trends change with ITS deployments. They must therefore be included in ITS PCB efforts.

A typical background includes knowledge of agency rules and regulations related to job classifications, descriptions and salary requirements. Backgrounds can also include either formal education in human resource management or many years of experience. If training is involved, a background in teaching is required.

Functions and Responsibilities:

- Work with Project Managers to hire or develop ideal team.
- Facilitate new job descriptions.
- Provide training.
- Hire and train operators on automated system use.
- Promote the acceptance of required operating changes

The following is a list of the recommended competencies to build the depth and breadth required for Human Resources Staff:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Transportation Fundamentals Software and Hardware Operations Operations, especially agency procedures	Organizational/Institutional Change (2) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Marketing/Public Relations

Recommended Core Training and Education for Human Resources Staff

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ ITS Public/Private Partnerships (NHI)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	* Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Course in change management (business schools, universities)
	✓ Recommended reading in ITS Institutional Issues (EDL)

Specialized Training	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	* Course in marketing/public relations basics (universities, junior colleges)
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS

ITS Curriculum — Systems Administrators/Support Technicians

Role Description: Systems Administrators and Support Technicians maintain computer systems including servers, workstation clients, software, related hardware and un-interruptible power supply systems. They manage the networks — both technical (Computer Aided Dispatching, remote device control, and infrastructure monitoring) and administrative (user accounts, e-mail and system security). They plan, install, and maintain software, and provide upgrades. Typically this individual is a “jack of all trades” who ends up doing some programming, database or spreadsheet design, or scripting.

Given that ITS deployments can have extensive computer systems that collect, organize and disseminate information to different agency departments as well as other agencies, Systems Administrators and Support Technicians have added responsibilities in helping to manage the flow of data and help plan for its archiving, for which further professional capacity building may be needed.

Functions and Responsibilities:

- Work with systems designers to ensure technical and technological feasibility of design.
- Assist systems integrators and software developers with installation and testing, including the integration of software with the hardware systems.
- Assist with the evaluation of ITS deployments.
- Maintain data network and server, including data archiving and backups.
- Maintain and update hardware and software; troubleshoot systems hardware and software problems.
- Manage network; manage user accounts.
- In cooperation with electronic maintenance technicians, repair and replace ITS technologies.
- Follow maintenance procedures for prevention.

The following is a list of the recommended competencies to build the breadth and depth required for Systems Administrators and Support Technicians:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Systems Integration (1) Technology Options (3) Systems Analysis and Design (4) Writing/Communications (7) Data Analysis and Management (10) Software Development ITS Legal Issues Project Evaluation Operations Transportation Fundamentals	Software and Hardware Operations Problem Solving Systems Support and Maintenance

Recommended Core Training and Education for Systems Administrators and Support Technicians

Awareness Training	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	<ul style="list-style-type: none"> ✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	<ul style="list-style-type: none"> ✓ ITS Telecommunications Overview (NHI)
	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	<ul style="list-style-type: none"> * Introductory courses on systems engineering, electrical engineering, telecommunications engineering, installing and integrating hardware and software, and testing methodologies (vendors, universities, technical/vocational schools)
	<ul style="list-style-type: none"> * Introductory courses on software integration and performance testing (vendors and universities)
	<ul style="list-style-type: none"> * Course on data analysis, management and databases (universities)
	<ul style="list-style-type: none"> * Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	<ul style="list-style-type: none"> ◇ Seminar on ITS Legal Issues

Specialized Training	If Transit Agency: <ul style="list-style-type: none"> ✓ Transit Performance Evaluation: Using Information-Based Strategies (NTI)
	<ul style="list-style-type: none"> * Courses on software applications such as word processing, spreadsheets, databases, or internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	<ul style="list-style-type: none"> * Advanced courses (and/or certifications) on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)
	<ul style="list-style-type: none"> * Advanced courses (and/or certifications) on repairing and maintaining electronics (vendors, technical/vocational schools, universities)

ITS Curriculum — Program/Agency Managers

Role Description: Program/Agency Managers are higher level agency decision makers. Whereas Project Managers are concerned with daily project activities throughout all the stages of deployment, Program/Agency Managers are concerned with how the ITS projects fit in with or impact other agency work, agency staffing and functioning, organizational and institutional changes, funding, and policy reform and legislative changes that facilitate smoother deployments.

This role is important especially in the mainstreaming of ITS into the transportation planning process. The Program/Agency Manager can ensure that an agency considers ITS as possible solutions to transportation problems and that projects are compliant with federal regulations. They can help to identify federal, state, local, and private sector funding sources and apply for them. They can ensure that all legal conformity requirements are met, for example, that the technologies are using accepted standards and are consistent with the National ITS Architecture. They may have to explore the possibility of promoting legislative, organizational, or policy change to facilitate ITS deployments.

Functions and Responsibilities:

- Provide outreach and education to senior decision makers and appointed and/or elected officials .
- Work to diminish agency and institutional barriers.
- Build coalitions among agencies and with the private sector.
- Form working groups and task forces.

The following is a list of the recommended competencies to build the ITS breadth and depth required for Program/Agency Managers:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness Technology Options (3) Systems Analysis and Design (4) ITS Planning (8) Data Analysis and Management (10) National ITS Architecture ITS Standards Procurement ITS Legal Issues Project Management Software and Hardware Operations Operations	Organizational/Institutional Change (2) Managing Contractors (5) Financing (6) Writing/Communications (7) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change Partnerships Marketing/Public Relations Problem Solving Transportation Fundamentals

Recommended Core Training and Education for Program/ Agency Managers

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or
	✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm)
	✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or
	✓ The National ITS Architecture : An Introduction for Senior FTA Staff (FTA)
	T NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	Technology Options: Depends on the type of ITS project
	✓ ITS and the Transportation Planning Process (NHI)
	For Transit Managers:
	✓ Intelligent Transportation Systems for Transit: Solving Real Problems (NTI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Lessons Learned in ITS Procurement (NHI)
	✓ ITS Telecommunications Overview (NHI)
	* Course in procurement and legal issues (U.S. DOT)
	* Introductory courses on the software development process, software integration, and performance measures and testing (U.S. DOT, vendors, and universities)
	* Introductory course on software applications such as databases, data analysis and management, and internet applications (junior colleges, universities, agency training programs, professional associations, software vendors)
	* Courses on project management (U.S. DOT, universities and junior colleges)
	* Introductory courses on operating and maintaining networks and software, and inspection and testing of systems (vendors, technical/vocational schools)

Specialized Training	✓ Managing Systems Integrators (ITSA)
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Software Acquisition (NHI)
	✓ Lessons in ITS Procurement (NHI)
	* Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting (U.S. DOT, universities, junior colleges)
	* Advanced course in writing business plans/ project plans (U.S. DOT, universities, professional associations)
	* Course in marketing/public relations basics (universities, junior colleges)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Advanced course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Seminar on ITS Legal Issues
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	* ITS America's Legislative Affairs web site: http://www.itsa.org/legislative.html

ITS Curriculum — Inter-jurisdictional Coordinators

Role Description: Inter-jurisdictional Coordinators facilitate cooperative structured working arrangements with all participating stakeholders. This involves identifying and bringing on all necessary agencies which can include police, fire, emergency as well as State and local transportation organizations, and private sector firms. Given that metropolitan areas often cross many jurisdictions, this role is particularly important for traffic signal coordination and Transportation Management Center projects. A solid understanding of the ITS planning process as well as the legal issues involved in policy changes is important for this role. Given the nature of ITS projects, it requires working with many jurisdictions, establishing agreements, and defining roles and levels of coordination.

Metropolitan ITS projects often cross jurisdictions given their integrative features. Thus, an Inter-jurisdictional Coordinator, who often is also the project manager or regional champion, can coordinate with various parties to overcome organizational and institutional barriers.

Functions and Responsibilities:

- Facilitate integration across jurisdictions and agencies.
- Track regional ITS deployments to identify opportunities for integration, leveraging of resources, and elimination of redundancies.
- Bring stakeholders from various agencies on board.
- Assist with policy, rules, and regulations changes when needed.

The following is a list of the recommended competencies to build the breadth and depth required for Inter-jurisdictional Coordinators:

Competency Recommendations at the Awareness Level	Competency Recommendations at the Specialized Level
ITS Awareness National ITS Architecture ITS Standards Partnerships Procurement Operations Transportation Fundamentals	Organizational/Institutional Change (2) Writing/Communications (7) ITS Planning (8) Identifying Stakeholders/Building Coalitions (9) Legislative and Policy Change ITS Legal Issues

Recommended Core Training and Education for Inter-jurisdictional Coordinators

Awareness Training	✓ ITS Awareness Seminar (NHI or internet: http://www.nawgits.com/nawg/itsaware/) or ✓ ITS in Transit (FTA)
	✓ Deploying Integrated ITS — Metropolitan (NHI or internet: http://www.its.dot.gov/pcb/deploygd.htm) ✓ Deploying Integrated ITS — Rural (NHI)
	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity (U.S. DOT) or ✓ The National ITS Architecture: An Introduction for Senior FTA Staff (FTA)
	✓ NTCIP and ITS Standards – What Do They Mean for You? (ITE)
	✓ ITS Public/Private Partnerships (NHI)
	✓ ITS Telecommunications Overview (NHI)
	✓ Lessons Learned in ITS Procurement (NHI)
	* Introductory course in transportation engineering to learn vocabulary and fundamentals of traffic and/or transit (universities, transportation professional associations)

Specialized Training	✓ ITS and the Transportation Planning Process (NHI)
	✓ Planning the Integration of Transit and Traffic ITS Applications (NTI)
	✓ Shared Resources for Telecommunications (NHI)
	* Advanced course in writing business plans/ project plans, writing specifications (U.S. DOT, universities, professional associations)
	* Advanced course in negotiations (U.S. DOT, universities, professional associations)
	* Course in procurement and legal issues (U.S. DOT)
	✓ Recommended reading in ITS Institutional and Legal Issues (EDL)
	◇ Seminar on ITS Legal Issues
	◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to incorporate ITS
	* ITS America's Legislative Affairs website: http://www.itsa.org/legislative.html

Definitions of ITS Competencies, Critical Knowledge & Skills, and Sources of PCB Training and Education

The following pages present a guide that identifies the available ITS training and education by competency. The guide also includes a more detailed definition of each competency, including a breakdown of the “bundled” critical knowledge and skills that comprise the competency. The top ten competencies are presented first, as it is assumed that these are the subjects most people will be interested in.

The training and education courses are listed using the same symbols as the curricula: a checkmark denotes courses that are identified and available with the presenting organization listed in parentheses; a star denotes courses, reading materials, and web sites that should be easily accessible from the organizations listed in parentheses; and a diamond denotes courses and reading materials that have not been identified. These courses and materials may exist or may need to be developed. Also included, is a notation where materials are available on the ITS Electronic Document Library (EDL).

• Systems Integration (1)	57-59
• Organizational/Institutional Change (2)	60-61
• Technology Options (3)	62-63
• Systems Analysis and Design (4)	64-66
• Managing Contractors (5)	67
• Financing (6)	68-69
• Writing/Communications (7)	70
• ITS Planning (8)	71-72
• Identifying Stakeholders/Building Coalitions (9)	73-74
• Data Analysis and Management (10)	75-76
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Competency #1 - Systems Integration: A comprehensive transportation system comprises a number of smaller individual transportation organizations and their facilities. The “system” encompasses all of them, even though each is complete and functional in its own right. Systems integration refers to bringing together specific components or devices with the appropriate connections. These devices include mechanical, electrical, software, hardware, telecommunications, fiber optics, microwave components or radio. Each device’s internal performance, its communication links to other devices and the system, the data input/output or manipulation, and the control mechanisms are part of a complex chain with many, potential “weak” links. The devices and the system as a whole must work properly and communicate accurately to the system with timely information to be of any use.

CRITICAL KNOWLEDGE AND SKILLS		AVAILABLE TRAINING/EDUCATION		
		From U.S DOT PCB Catalog		Other Sources
		What	Access	
Transportation and ITS deployment operations	Awareness	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS- Metropolitan ✓ Deploying Integrated ITS- Rural 	<ul style="list-style-type: none"> NHI NHI 	* Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications 	<ul style="list-style-type: none"> NTI 	
National ITS Architecture and Interim Guidance on Conformity	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	<ul style="list-style-type: none"> U.S. DOT FTA 	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by professional associations and vendors
	Specialized	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment -- Public ✓ Using the National ITS Architecture for Deployment -- Private ◇ Turbo Architecture 	<ul style="list-style-type: none"> U.S. DOT U.S. DOT U.S. DOT 	

(Systems Integration, cont' d)

Systems engineering and device configuration	Awareness			* Courses on systems engineering and electrical engineering offered by universities and vendors
	Specialized			
Telecommunications engineering	Awareness	✓ ITS Telecommunications Overview	NHI	* Recommended reading: JPO' s <i>Telecommunications Resource Guide</i> * Courses on telecommunications engineering, networking and fiber optics offered by universities and vendors
	Specialized	✓ ITS Telecommunications Analysis	NHI	
Install and integrate hardware and software in networks and integration with existing systems	Awareness			* Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors * Recommended reading: * <i>Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in the USA: FY 1997 Results</i> , FHWA-JPO-99-001 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i> , DOT-T-94-25 (EDL)
	Specialized			
Data and database management	Awareness			* Courses on data analysis, management and databases offered by universities and professional associations
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications	NTI NTI	
ITS Standards, protocols, and interfaces	Awareness	✓ NTCIP and ITS Standards – What Do They Mean for You?	ITE	
	Specialized	◇ National ITS Standards Training Modules	U.S. DOT	
Risk Analysis	Awareness			* Courses in public sector financial management: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized		U.S. DOT	

(Systems Integration, cont' d)

Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Electronics	Awareness	✓ Advanced Transportation Management Technology Workshop ✓ Procuring New Technologies for Transit ✓	FHWA NTI	
	Specialized	✓ Freeway Traffic Operations ✓ Traffic Control Software and Signalization ✓ Computerized Traffic Signal Systems ✓ Advanced Traffic Signal Controllers ✓ HOV Facilities ✓ Sensors, Data Exchange, and Interoperability ✓ NTI Workshop on Advanced Technologies and Innovative Practices for Transit ✓ Geographic Information Systems: Transit Applications	NHI NHI NHI NHI NHI ITS America NTI NTI	
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		* Course in writing business plans and/ or project plans offered by U.S. DOT, universities or professional associations * Course in project management offered by U.S. DOT, universities or junior colleges * Course in negotiations offered by universities or professional associations
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	

Competency #2 – Organizational/institutional change: ITS will challenge agencies to change their mission and approach to operations as advanced technology deployments become more interagency and systems-oriented. Given that agencies are accustomed to operating based on modal thinking, institutional issues become the greatest non-technical barrier to ITS deployments. These issues will address how agencies can leverage funding, facilities and staff to avoid redundancies. It will also concern how agencies can plan, design, install, operate, and maintain ITS more effectively through the cooperation of multiple stakeholders.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Identifying Stakeholders/ Coalition Building (also, see competency definition on page 70)	Awareness	<ul style="list-style-type: none"> ✓ ITS Awareness Seminar ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff ✓ Deploying Integrated ITS — Metropolitan ✓ Deploying Integrated ITS —Rural 	<p>NHI</p> <p>NHI</p>	<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i>, FHWA-JPO-99-032 (EDL) * <i>The New York-New Jersey-Connecticut Metropolitan Model Deployment Initiative: A Review of the Initial Negotiations Process</i>, FHWA-JPO-98-033 (EDL)
	Specialized			
Understanding the Political Environment	Awareness			<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Traveling with Success: How Local Government Use Intelligent Transportation Systems</i>, FHWA-JPO-96-009 (EDL) * <i>ITS Market Resource Guide: Federal, State, and Local Contacts in ITS</i>, ITS America.
	Specialized			
Policy Skills	Awareness			
	Specialized			

(Organizational/Institutional Change, cont' d)

Financing	Awareness			* Courses in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting offered by U.S. DOT, universities or junior colleges
	Specialized	<ul style="list-style-type: none"> ✓ Shared Resources for Telecommunications ✓ ITS Software Acquisition 	NHI NHI	
Project Evaluation	Awareness	✓ Transit Performance Evaluation: Using Information-Based Strategies	NTI	* Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, cost/benefit analysis after deployment		
Partnerships	Awareness	✓ ITS Public/Private Partnerships	NHI	
	Specialized	✓ Shared Resources for Telecommunications	NHI	
Procurement	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	* Courses in procurement and legal issues offered by U.S. DOT * Recommended reading in ITS Institutional and Legal Issues (search on the EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Procuring New Technologies for Transit ◇ Seminar on ITS Legal Issues ◇ Seminar on using and writing ITS contracts and ITS specifications 	NTI	
Organizational change/ Change Management	Awareness			* Courses in change management offered by business schools, universities, or professional associations * Courses in marketing and public relations offered by universities or professional associations * Courses in negotiations offered by U.S. DOT, universities or professional associations
	Specialized			

Competency #3 - Technology Options: ITS introduces the application and use of advanced technologies into surface transportation. With most capital projects, transportation professionals have not required a background in high tech. However, in ITS, in order to understand the range of options available, new or enhanced skills to choose the most appropriate technology are needed. These technologies generally include communications and networks, computers and computing technologies that constitute information systems, diagnostics, electronics, and detection and surveillance technologies. Skills needed include understanding the nomenclature, specifications, functional use and limitations of the various technologies, and the difference between competing products or solutions.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Range of ITS technologies and Electronics	Awareness	<ul style="list-style-type: none"> ✓ Intelligent Transportation Systems Awareness Seminar ✓ ITS in Transit 	<ul style="list-style-type: none"> NHI FTA 	
	Specialized	<ul style="list-style-type: none"> ✓ Advanced Transportation Management Technology Workshop ✓ Incident Management ✓ Freeway Traffic Operations ✓ Traffic Control Software and Signalizations ✓ Computerized Traffic Signal Systems ✓ Advanced Traffic Signal Controller ✓ NTI Fellows Workshops on Advanced Technologies and Innovative Practices for Transit ✓ Procuring New Technologies for Transit ✓ High Occupancy Vehicle Facilities ✓ Video Communications Systems ✓ Traffic Management Systems ✓ Traffic Surveillance Systems 	<ul style="list-style-type: none"> FHWA NHI NHI NHI NHI NHI NTI NTI NHI (TBD) Vendors Vendors Vendor 	

(Technology Options, cont' d)

Technology benefits and performance assessment	Awareness			
	Specialized	<ul style="list-style-type: none"> ◇ Use of the CORSIM Computer Traffic Simulation Model ◇ Other planning models ✓ Intelligent Transportation Systems for Transit: Solving Real Problems ✓ Reinventing Transit: Planning Information-Based Transit Services ✓ Transit Performance Evaluation: Using Information-Based Strategies 	U.S. DOT NTI NTI NTI	
Writing specifications and procurement	Awareness			* Recommended reading: <i>The Road to Successful ITS Software Acquisition, Executive Summary</i> FHWA-JPO-98-037, <i>Volume 1: Overview and Themes</i> , FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i> , FHWA-JPO-98-036 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ ITS Software Acquisition ◇ Lessons Learned in ITS Procurement ◇ Seminar on using and writing ITS contracts and ITS specifications 	NHI	
Repair and Maintenance	Awareness			* Courses on repairing and maintaining electronics offered by vendors, technical/vocational schools, universities * Repair and maintenance procedures manuals received from vendors
	Specialized			
Training on ITS devices and equipment	Awareness			* Courses offered by vendors after installation * Operations procedures manuals received from vendors
	Specialized			
Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	<ul style="list-style-type: none"> ◇ Workshop on setting ITS systems performance measures, and inspection and testing 		

Competency #4 - Systems Analysis and Design: ITS requires designing systems using a comprehensive integrative approach. Include identifying user needs, analyzing the network infrastructure, and developing or adapting software. In doing this, it is important to clearly define what the system is expected to do now and in the future. Identification of technology risks and costs. The architecture can be used as a tool in the planning stages. One must fully analyze potential capabilities and limitations using a life cycle approach. Looking at investment costs, operations and maintenance costs, staffing and training are all important.

CRITICAL KNOWLEDGE AND SKILLS		AVAILABLE TRAINING/EDUCATION		
		From U.S DOT PCB Catalog		Other Sources
		What	Access	
Transportation and ITS deployment operations	Awareness	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS- Metropolitan ✓ Deploying Integrated ITS- Rural 	<ul style="list-style-type: none"> NHI NHI 	* Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications 	<ul style="list-style-type: none"> NTI 	
User Needs Assessments	Awareness			* Workshops on conducting user needs assessments offered by universities, continuing education programs, or professional associations
	Specialized			
National ITS Architecture and Interim Guidance on Conformity	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	<ul style="list-style-type: none"> U.S. DOT FTA 	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by professional associations and vendors
	Specialized	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment -- Public ✓ Using the National ITS Architecture for Deployment -- Private ◇ Turbo Architecture 	<ul style="list-style-type: none"> U.S. DOT U.S. DOT U.S. DOT 	

(Systems Analysis and Design, cont' d)

Systems engineering and device configuration	Awareness			* Courses on systems engineering and electrical engineering offered by universities and vendors
	Specialized			
Telecommunications engineering	Awareness	✓ ITS Telecommunications Overview	NHI	✓ Recommended reading: JPO' s <i>Telecommunications Resource Guide</i> * Courses on telecommunications engineering, networking and fiber optics offered by universities and vendors
	Specialized	✓ ITS Telecommunications Analysis	NHI	
Install and integrate hardware and software in networks and integration with existing systems	Awareness			* Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors * Recommended reading: * <i>Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in the USA: FY 1997 Results</i> , FHWA-JPO-99-001 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i> , DOT-T-94-25 (EDL)
	Specialized			
Data and database management	Awareness			* Courses on data analysis, management and databases offered by universities and professional associations
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications	NTI NTI	
ITS Standards, protocols, and interfaces	Awareness	✓ NTCIP and ITS Standards – What Do They Mean for You?	ITE	
	Specialized	◇ National ITS Standards Training Modules	U.S. DOT	
Analysis	Awareness			Courses in analysis: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized		U.S. DOT	

(Systems Analysis and Design, cont' d)

Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Electronics	Awareness	✓ Advanced Transportation Management Technology Workshop ✓ Procuring New Technologies for Transit ✓	FHWA NTI	
	Specialized	✓ Freeway Traffic Operations ✓ Traffic Control Software and Signalization ✓ Computerized Traffic Signal Systems ✓ Advanced Traffic Signal Controllers ✓ HOV Facilities ✓ Sensors, Data Exchange, and Interoperability ✓ NTI Workshop on Advanced Technologies and Innovative Practices for Transit ✓ Geographic Information Systems: Transit Applications	NHI NHI NHI NHI NHI ITS America NTI NTI	
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		* Course in writing business plans and/ or project plans offered by U.S. DOT, universities or professional associations * Course in project management offered by U.S. DOT, universities or junior colleges * Course in negotiations offered by universities or professional associations
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	

Competency #5 - Managing Contractors: Many state and local transportation agencies must train in-house staff to manage contractors on ITS projects. First, many agencies have hiring freezes and/or are downsizing leaving many advanced technology projects designed and installed by contractors. Second, university and college graduate transportation programs are not preparing students in the advanced technology skills needed to deploy ITS. Third, given that the hi-tech industry is intensely competitive, it is hard to attract electrical engineers and software developers to the public service given government salary caps. This leaves agencies with many mid-level staff that need to be trained to manage contractors on unfamiliar technology projects.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		* Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	
Procurement	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	* Courses in procurement offered by U.S. DOT
	Specialized	✓ Procuring New Technologies for Transit ◇ Workshop on using and writing ITS contracts and ITS specifications	NTI	
Organizational/ Institutional Issues	Awareness	◇ Workshop on bridging public-private sector differences		* Recommended reading in ITS institutional and legal issues (search on the EDL) * Courses in change management offered by business schools, universities or professional associations * Courses in negotiations offered by U.S. DOT, universities, or professional associations
	Specialized			

Competency #6 - Financing: Currently funding is designated to specific transportation agencies. This “stove-piped” approach inhibits interagency cooperation on ITS projects. Funding mechanisms need to change to alleviate this barrier. Innovative financing such as new tolls, video enforcement ticketing, user fees, and public-private partnerships can also assist in financing ITS projects. Agencies could also initiate new procurement strategies that would leverage their positions to purchase technologies at low cost. Need for funding systems operations and maintenance. Many times funds have been provided to design and install a system but the high costs for operations and maintenance makes running the system prohibitive.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
TEA-21 planning and financing provisions	Awareness	✓ ITS and the Transportation Planning Process	NHI	
	Specialized			
Investment analysis and benefit-cost analysis	Awareness	✓ Intelligent Transportation Systems Awareness Seminar	NHI	* Courses in public sector financial management: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies	NTI	
		✓ Reinventing Transit: Planning Information-Based Transit Services	NTI	
		✓ Intelligent Transportation Systems for Transit: Solving Real Problems	NTI	
Risk analysis	Awareness			* Courses in public sector financial management: cost/benefit analysis, investment analysis, and risk analysis offered by U.S. DOT, universities or junior colleges
	Specialized			

(Financing, cont' d)

Procurement	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	
	Specialized	✓ Procuring New Technologies for Transit ✓ Procuring and Managing Systems Integrators ◇ Workshop on using and writing ITS contracts and ITS specifications	NTI ITS America	* Recommended reading: * <i>Innovative Contracting Practices for ITS, Executive Summary</i> , L.S. Gallegos & Associates, Inc (EDL) * <i>The Road to Successful ITS Software Acquisition, Executive Summary</i> , FHWA-JPO-98-037, Volume 1: Overview and Themes, FHWA-JPO-98-025, and Volume 2: Software Acquisition Process Reference Guide, FHWA-JPO-98-036 (EDL)
Identifying Sources of Funding	Awareness			* Technical assistance from U.S. DOT headquarters, FTA Regional Office ITS Specialists, and FHWA Resource Center and Division Office ITS Specialists
	Specialized			

Competency #7 – Writing/Communications: ITS requires precision and effective interactions between individuals in internal and external organizations. It includes verbal and written communications, including oral presentations and report writing. Negotiations are about persuading individuals to consider an issue or line of reasoning. The types of documents that are important include RFPs, contracts, MOUs, specifications writing, and requirements writing.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Writing specifications and RFPs for ITS projects	Awareness			* Course in writing business plans or project plans offered by U.S. DOT, universities or professional associations
	Specialized	◇ Workshop on using and writing ITS contracts and ITS specifications		
Negotiations	Awareness			* Courses in negotiations offered by U.S. DOT, universities, professional associations
	Specialized			
Managing contractors	Awareness	◇ Workshop on bridging public-private sector differences		
	Specialized	✓ Procuring and Managing Systems Integrators	ITS America	
Technical and Legal issues associated with writing RFPs for ITS deployment	Awareness			* Course on Intellectual Property Rights, Copyrights and Patents from law schools * Recommended reading in ITS institutional and legal issues (search on the EDL)
	Specialized	✓ ITS Software Acquisition ◇ Seminar on ITS Legal Issues	NHI	

Competency #8 - ITS Planning: As ITS capabilities become ready for deployment through the use of regular funding sources, they will encounter the established transportation planning and programming process, requiring choices among competing projects within financial and other constraints. ITS introduces the need for transportation agencies to work more closely to achieve a common regional vision in planning and operations for the transportation system. ISTEA and TEA-21 strongly encourage alternatives to traditional transportation construction. ITS does not change the well-developed planning process. Rather, it necessitates new considerations of ITS projects as alternatives and complements to more traditional capital projects. ITS introduces new federal requirements through the long-range plans (LRPs) and transportation improvement programs (TIPs). It also requires a change in focus from less capital construction to more effective management of the existing transportation network. The role of planning in ITS deployments has increased with ISTEA and TEA-21 to focus on more regional operations and management.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Developing a Regional Concept of Operations for ITS and Mainstreaming ITS	Awareness	<ul style="list-style-type: none"> ✓ ITS and the Transportation Planning Process ✓ An Introduction: The National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	NHI NHI FTA	* Recommended reading: * <i>Integrating Intelligent Transportation Systems within the Transportation Planning Process: An Interim Handbook</i> , FHWA-SA-98-048 (EDL) * <i>Streamlining ITS Planning, Identifying Common Needs: National ITS Architecture</i> , FHWA-JPO-99-013 (EDL# 6865) * <i>Tracking the Deployment of the Integrated Metropolitan ITS Infrastructure in the USA: FY 1997 Results</i> , FHWA-JPO-99-001 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications 	NTI	
Transportation Planning fundamentals	Awareness			* Courses on planning, land use, and transportation offered by universities and professional associations
	Specialized			

(ITS Planning, cont' d)

Project Evaluation and Analysis	Awareness	✓ Intelligent Transportation Systems Awareness Seminar	NHI	* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges * Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	✓ Reinventing Transit: Planning Information-Based Transit Services ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Use of the CORSIM Computer Traffic Simulation Model ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, and cost/benefit analysis after deployment	NTI NTI U.S. DOT	
GIS and mapping	Awareness			
	Specialized	✓ Geographic Information Systems: Transit Applications	NTI	
Negotiations	Awareness			* Course in negotiations offered by U.S. DOT, universities or professional associations
	Specialized			
Environmental and Societal Impacts	Awareness			
	Specialized	◇ Workshop in analyzing the environmental impacts of ITS including air quality, noise, energy and environmental justice		

Competency #9 - Identifying Stakeholders/Building Coalitions: ITS requires that transportation agencies, firms, and professionals who are involved in the shift to systems operations and management work in cooperation with one another. This requires setting goals and developing a regional concept of operations together. Frequently, ITS includes stakeholders from non-transportation agencies, such as law enforcement and emergency personnel.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Developing a Regional Concept of Operations for ITS	Awareness	✓ Deploying Integrated ITS- Metropolitan	NHI	* Systems engineering courses offered by vendors and universities * Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
		✓ Intelligent Transportation Systems Awareness Seminar	NHI	
		✓ Deploying Integrated ITS- Rural	NHI	
	Specialized	✓ Shared Resources for Telecommunications ✓ Planning the Integration of Transit and Traffic ITS Applications	NHI NTI	
Planning fundamentals	Awareness	✓ ITS and the Transportation Planning Process	NHI	* Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	✓ Reinventing Transit: Planning Information-based Transit Services	NTI	
		✓ Planning the Integration of Transit and Traffic ITS Applications	NTI	
User Needs Assessments	Awareness			* Workshops on conducting user needs assessments offered by universities, continuing education programs, or professional associations
	Specialized			
Partnerships and Coalition building	Awareness	✓ ITS Public/Private Partnerships	NHI	
	Specialized	✓ Shared Resources for Telecommunications	NHI	

(Identifying Stakeholders/Building Coalitions, cont' d)

Negotiations	Awareness			* Courses in negotiations offered by U.S. DOT, universities or professional associations
	Specialized			
ITS project management	Awareness	◇ Workshop on bridging public-private sector differences		
	Specialized	✓ Procuring and Managing Systems Integrators	ITSA	

Competency #10 - Data Analysis and Management: Many transportation professionals desire to understand what data might be produced and how it might be utilized in decision-making. Data can be used to determine traffic trends, patterns and growth for planning, operations and maintenance staff. Data analysts and managers must first look at how data is distributed within and amongst agencies to see if systems are compatible. Linkages might have to be made amongst agencies to see if systems are compatible. Linkages might have to be made amongst systems thus adding a step in conversion and translation of data from one system to the next. The proliferation of data collection devices and advances in database technologies creates a situation in which so much information is available that it can be overwhelming. The value of the system is closely related to how the data is managed. Effective use involves issues such as one-way data sharing versus multiple and real-time sharing as well as data consistency and accuracy, archiving and storage, analysis and interpretation, and privacy.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
National ITS Architecture and Data sharing between agencies	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	U.S. DOT FTA	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by vendors
	Specialized	◇ Turbo Architecture	U.S. DOT	
Transportation and ITS deployment operations	Awareness	<ul style="list-style-type: none"> ✓ Deploying Integrated ITS- Metropolitan ✓ Deploying Integrated ITS- Rural 	NHI NHI	* Systems engineering courses offered by vendors and universities
	Specialized	✓ Planning the Integration of Transit and Traffic ITS Applications	NTI	
Protocols, standards, and interfaces	Awareness	✓ NTCIP and ITS Standards -- What Do They Mean for You?	ITE	
	Specialized	◇ National ITS Standards Training Modules		
Testing procedures, setting performance measures, quality assurance/quality control on databases and software once integrated	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		

(Data Analysis and Management, cont' d)

Data and database management, maintenance and archiving	Awareness			<ul style="list-style-type: none"> * Courses on building databases and relational databases offered by universities * Recommended reading: <ul style="list-style-type: none"> * <i>ITS As A Data Resource: Preliminary Requirements for a User Service</i> (EDL) * <i>Archived Data User Services (ADUS): An Addendum to the ITS Program Plan, Final Version</i>, (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications 	NTI NTI	
Install and integrate hardware and software in networks and ensure systems security	Awareness	✓ ITS Software Acquisition	NHI	<ul style="list-style-type: none"> * Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors * Recommended reading: <ul style="list-style-type: none"> * <i>Protecting Our Transportation Systems: An Information Security Awareness Overview</i>, FHWA-JPO-98-005 (EDL) * <i>The Road to Successful ITS Software Acquisition, Executive Summary</i> FHWA-JPO-98-037, <i>Volume 1: Overview and Themes</i>, FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i>, FHWA-JPO-98-036 (EDL) * <i>Protecting Our Transportation Systems: An Information Security Awareness Overview</i>, FHWA-JPO-98-005 (EDL)
	Specialized			
Training on the use of databases	Awareness			<ul style="list-style-type: none"> * Courses offered by database developers after installation and integration * Operations procedures manuals received from vendors
	Specialized			

ITS Awareness: The introduction of ITS has required that new disciplines bring unfamiliar knowledge and skills to the transportation industry. An understanding of what ITS is comprised of and the scope of the program and its goals, is a critical and basic element in achieving effective and successful ITS deployments and operations. ITS Awareness is the one competency area that is not a mix of knowledge and skills. Instead, it is being cognizant of ITS and having:

- an understanding of what ITS is, why it came about, and what it achieves;
- vocabulary and terminology that is common to ITS;
- a working definition of ITS —the components, how they fit together, and methods of deploying and operating;
- a sense of the role transportation professionals and their agencies perform in deploying and operating the transportation system with ITS, and;
- an understanding of the benefits that result from systems operations and management of the transportation system and from interagency cooperation to achieve intermodalism;
- an understanding of the ITS program areas applicable to the type of planned deployment (each program area has its own page at the end of this resource guide).

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Awareness	Awareness	✓ Intelligent Transportation Systems Awareness Seminar	NHI or internet	* Recommended reading: * <i>1996 ITS Report to Congress</i> , FHWA-JPO-97-026 (EDL) * <i>1997 ITS Report to Congress</i> , FHWA-JPO-98-034 (EDL) * <i>ITS Benefits: Continuing Successes and Operational Test Results</i> , FHWA-JPO-98-002 (EDL) * <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	✓ Deploying Integrated ITS—Metropolitan ✓ Deploying Integrated ITS—Rural	NHI NHI	

National ITS Architecture: To realize the full potential of ITS, a unified framework for integration, called “the National ITS Architecture” was developed to guide the coordinated deployment of ITS by public agencies and private organizations alike. The National ITS Architecture defines the functions performed by ITS components and the various ways in which they can be interconnected. The Architecture is a tool that allows agencies to envision systems, and design projects and deployment approaches for meeting near-term needs while keeping options open for eventual system expansion and integration. The National ITS Architecture does not represent a specific design. Rather, it provides decision points from which stakeholders can work together to make the vision of a unified ITS for their region a reality. The Architecture provides choices that allow deployments to be tailored to localized needs and preferences. The Architecture provides advice on where standards are useful for ensuring interoperability.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff 	U.S. DOT FTA	<ul style="list-style-type: none"> * Courses on National ITS Architecture, NTCIP, and ITS concepts offered by vendors * Recommended reading: <i>Streamlining ITS Planning, Identifying Common Needs: National ITS Architecture</i>, FHWA-JPO-99-013 (EDL# 6865)
Use of the Architecture in planning and design	Specialized	<ul style="list-style-type: none"> ✓ Using the National ITS Architecture for Deployment —Public Sector ✓ Using the National ITS Architecture for Deployment —Private Sector ◇ Turbo Architecture 	U.S. DOT U.S. DOT U.S. DOT	<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Developing ITS Using the National Architecture: An Executive Edition for Senior Transportation Managers</i>, FHWA-JPO-98-025 (EDL) * <i>National ITS Architecture Transit Guidelines</i>, FHWA-JPO-97-0016 (EDL) * <i>Developing Freeway and Incident Management Systems Using the National ITS Architecture</i>, FHWA-JPO-98-032 (EDL) * <i>Developing Traveler Information Systems Using the National ITS Architecture</i>, FHWA-JPO-98-031 (EDL) * <i>Developing Traffic Signal Control Systems Using the National ITS Architecture</i>, FHWA-JPO-98-026 (EDL)

(National ITS Architecture, cont' d)

Integration with existing infrastructure	Awareness	◇ Modules on tracking existing infrastructure		<ul style="list-style-type: none"> * Course on systems engineering and integration offered by universities * Recommended reading: <ul style="list-style-type: none"> * <i>Tracking the Deployment of the Integrated Metropolitan Intelligent Transportation Systems Infrastructure in the USA: FY 1997 Results</i>, FHWA-JPO-99-001 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i>, DOT-T-94-25 (EDL)
	Specialized			

Partnerships: ITS introduces the opportunity for, and in some cases has required, that agencies and firms work closely together to share resources, costs, risks and rewards of reaching project goals. Partnering takes many forms in ITS depending on the project and partners. It includes public-public partnerships among agencies and public-private partnerships between agencies and firms.

Frequently, forums that are used to build coalitions also provide opportunities for recognizing mutually beneficial partnerships. Partnerships have basic legislative and financial parameters and barriers. They require clear documentation—either Memorandums of Understanding (MOUs) or contracts—describing many important issues. It is important to include staff at all levels in structuring partnership agreements to ensure buy-in and the feasibility of the goals. The following should be considered when structuring partnerships:

- partner's expectations, goals and steps for achieving them;
- the agency's or firm's authority, responsibilities, technical capabilities, statutory limitations, time and funding constraints;
- the agency's or firm's priorities regarding the partnership (for example, after systems installation and testing, which partner will maintain the system?);
- market requirements and financial stability;
- responsibilities regarding decision-making during incidents, control of ITS devices, and data sharing;
- provisions for sharing software and hardware, staff, and operations and maintenance costs;
- contract clauses that clearly spell out how monies will be distributed and contract clauses that describe that agency personnel staffed on the project have the technical expertise needed to do the job.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education			
		From DOT PCB Catalog		Other Sources	
		What	Access		
Benefits of Partnering	Awareness	✓ Public/Private Partnerships	NHI	* Recommended reading: <i>PCB Shared Resources: Sharing Right-Of-Way for Telecommunications: Guidance on Legal and Institutional Issues</i> , FHWA-JPO-96-0015 (EDL)	
	Specialized	✓ Shared Resources for Telecommunications	NHI		
Structuring Agreements	Awareness			* Course on Intellectual Property Rights, Copyrights and Patents from law schools * Courses in writing contracts and Memorandums of Understanding (MOUs) from U.S. DOT * Recommended reading in ITS Institutional and Legal Issues (EDL) * Recommended reading: <i>The New York-New Jersey-Connecticut Metropolitan Model Deployment Initiative: A Review of the Initial Negotiations Process</i> , FHWA-JPO-98-033 (EDL)	
	Specialized	◇ Workshop on using and writing ITS contracts			

ITS Standards: The foundation of intermodal, interoperable ITS is based on a need for, and compliance with, technical standards. ITS requires that new standards be developed that address, for example, communication protocols. Having these standards brings about many benefits. First, decision-makers can be assured that standardized technologies are being used and no future retrofitting will have to occur. Second, it assures interconnectivity and compatibility of systems. Third, standards allow for the manufacture of “open” or non-proprietary systems, that also allows customers a wider choice of technologies which enables growth of economies of scale and consequently reduced prices. The definition and publication of the complete set of ITS standards should help promote vendor growth and stability, and in turn provide the necessary economies of scale to lower prices.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Applying ITS Standards, protocols, and interfaces	Awareness	✓ NTCIP and ITS Standards —What Do They Mean for You?	ITE	* Recommended web site: http://www.its.dot.gov/standard/standard.htm
	Specialized	◇ National ITS Standards Training Modules		
Relationship to the National ITS Architecture	Awareness	✓ An Introduction: The National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards	U.S. DOT	
	Specialized	◇ National ITS Standards Training Modules		

Software & Hardware Operations: ITS requires an understanding of how to operate computers including various operating systems and software packages. It is similar to Technology Options, but focuses on the *application* of these technologies. This competency is as simple as turning on a computer, to identifying and troubleshooting simple problems, to communicating with systems support for more sophisticated problems. Typical tasks include installing and operating a software package, maintaining files and extracting data, and knowing proper shut down and re-boot procedures. It includes some organizational change in that it changes the way transportation business is done. As one senior executive related, the introduction of computer system networks meant that staff no longer worked in isolation--if one person was not doing their job, it had an effect on others in the system.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Procure hardware and software	Awareness	✓ ITS Software Acquisition ◇ Lessons Learned in ITS Procurement	NHI NHI	* Recommended reading: <i>The Road to Successful ITS Software Acquisition, Executive Summary FHWA-JPO-98-037, Volume 1: Overview and Themes</i> , FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i> , FHWA-JPO-98-036 (EDL)
	Specialized			
Install and integrate hardware and software in networks	Awareness			* Courses on installing and integrating hardware and software, and testing methodologies offered by universities and vendors * Courses on inspecting, operating and maintaining networks and software offered by universities and vendors * Courses on the software development process offered by universities and vendors
	Specialized			
Operate and maintain networks, servers and software	Awareness			* Courses on the software development process, programming and languages offered by universities, technical/vocational schools, or junior colleges * Courses on operating and maintaining networks and software, and inspection and testing of systems offered by vendors, technical/vocational schools, or universities
	Specialized			

(Software and Hardware Operations, cont' d)

Data and database management and maintenance	Awareness			* Courses on data analysis, management and databases offered by universities and professional associations
	Specialized	✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications	NTI NTI	
Software Applications	Awareness			* Courses on software applications such as word processing, spreadsheets, databases, or internet applications offered by junior colleges, universities, agency training programs, professional associations or software vendors
	Specialized			
Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Integration with existing systems, expandability and extendability	Awareness			* Course on systems engineering and integration offered by universities
	Specialized			

Software Development: Software is the heart and blood of computer systems. Many issues must be considered in software development since the process is often fraught with cost overruns and lack of usability. Decisions on when to develop software from scratch and when to modify must be made. Life cycle and cost analyses are done to support these decisions and monitor software development costs in the near and long term. Device control, transmission protocols, data capture and storage are elements of software development. Data sharing is also a crucial element. Decisions on what data gets shared with whom must also be done. Agencies can collaborate on projects to maximize return on costly development cycles. Extendibility and expandability of the software must also be considered. Maintenance issues such as upgrades, the software's reliability, backups and redundancies all have to be addressed. Related issues of hardware procurement must be evaluated so the system has the right platform to operate the software. Developers must have a thorough understanding of the transportation problem the software is aimed to address. This requires a good understanding of transportation fundamentals and terminology.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Software Development	Awareness			<ul style="list-style-type: none"> * Courses on the software development process, programming and languages offered by universities, technical/vocational schools, or junior colleges * Courses on operating and maintaining networks and software, and inspection and testing of systems offered by vendors, technical/vocational schools, or universities
	Specialized			
Software Acquisition	Awareness			<ul style="list-style-type: none"> * Course on Intellectual Property Rights, Copyrights and Patents from law schools * Courses in writing contracts and Memorandums of Understanding (MOUs) from U.S. DOT * Recommended reading in ITS Institutional and Legal Issues (EDL) * Recommended reading: <i>The Road to Successful ITS Software Acquisition, Executive Summary</i>, FHWA-JPO-98-037, <i>Volume 1: Overview and Themes</i>, FHWA-JPO-98-025, and <i>Volume 2: Software Acquisition Process Reference Guide</i>, FHWA-JPO-98-036 (EDL)
	Specialized	<ul style="list-style-type: none"> ✓ ITS Software Acquisition ◇ Lessons Learned in ITS Procurement 		

(Software Development, cont' d)

Electrical Engineering	Awareness			* Courses in electrical engineering and wiring networks offered by universities
	Specialized			
Human Factors	Awareness			* Courses in software engineering and human factors, especially human interface design, offered by universities * Recommended Reading: <i>Design of an ITS Level Advanced Traffic Management System: A Human Factors Perspective</i> , FHWA-JPO-
	Specialized			
Analysis	Awareness			* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges
	Specialized			
User Needs Assessment	Awareness			* Workshops on conducting user needs assessments offered by universities, continuing education programs, or professional associations
	Specialized			
Integration with existing systems, expandability and extendability	Awareness			* Course on systems engineering and integration offered by universities
	Specialized			
Training on the use of databases and software applications	Awareness			* Courses offered by software and database developers after installation and integration * Operations procedures manuals received from vendors
	Specialized			

ITS Human Factors: ITS introduces and requires making advanced technologies user-friendly. This particularly relates to the ergonomics of technology and system design for Variable Message Signs (VMS) and Traffic Management Centers (TMC). VMS messages, for example, need to be concise and easily readable by transportation users. Great care must go into how much information should be included in a message so that users can read it moving at the speed limit. Therefore, research on driving reaction to VMS should be done. VMS must also be placed in locations where users have enough time to make alternative route decisions. TMC consoles must be designed to be user-friendly for operators. For example, operators need easy access to different control mechanisms in split second time. Consoles should thus be designed to allow for quick usage of key elements in a sequential execution that reflects agency procedures. This will help operators to be more comfortable in executing their tasks. Human factors research also can allow for a more comfortable transition from manual to automated functions in that users will slowly trust computer capabilities.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Human Factors in ITS	Awareness			* Recommended reading: * <i>Summary reports on Human Factors Research Needs</i> No. FHWA-RD-98-147 and FHWA-RD-98-184 through –188 (EDL) * <i>Design of an ITS-Level Advanced Traffic Management System: A Human Factors Perspective</i> , FHWA-RD-95-181 (EDL)
	Specialized			
Human Factors Engineering	Awareness			* Courses on human factors offered by universities
	Specialized			
Human factors and software engineering	Awareness			* Course on software engineering and human factors, especially human interface design offered from universities
	Specialized			

Procurement: ITS requires changes in contracts and procurement processes. Whereas capital projects are most often based on low-bid, ITS projects may require design-build or fixed price plus fee contracts. Procurement processes can have unique elements because of an agency's culture. For example, agencies may have certain specification requirements and rules of procurement that may be an obstacle to advanced technology purchases. Long approval processes could also burden the project and result in technologies being outdated once deployed. Life cycle analysis and costs should be performed on alternative procurement options. Specification writing is of paramount importance in ITS projects given the newness of technologies. Furthermore, ITS systems are not easily "spec'ed out" due to unique technological, geographical and agency requirements. Thus, standard "off the shelf" contracts are difficult to use. Contracts should be based on the Scope of Work from the RFP instead of the contractor's bid. This will better ensure that project objectives are met since the bid is based on the contractor's capabilities. Contract clauses should clarify source code ownership, testing criteria, use of proprietary platforms and software, and performance standards for contractors. They should also spell out liability and risk sharing, reward sharing, dedication of resources, the extendibility and expandability of the system, use of prototypes, staff training on the system, and warranties. Legislation changes may have to occur in order to allow the usage of new contracts.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Procurement options, contracts and legal issues	Awareness	◇ Lessons in ITS Procurement	U.S. DOT	* Course in procurement and legal issues offered by U.S. DOT * Recommended reading: ITS institutional and legal issues (search on the EDL)
	Specialized	✓ Procuring New Technologies for Transit ✓ Procuring and Managing Systems Integrators ✓ ITS Software Acquisition ◇ Workshop on using and writing ITS contracts and ITS specifications ◇ Seminar in ITS Legal Issues	NTI ITS America NHI	
Identifying Sources of Funding	Awareness			* Technical assistance from U.S. DOT headquarters, FTA Regional Office ITS Specialists, and FHWA Resource Center and Division Office ITS Specialists
	Specialized			

Project Evaluation: Project evaluation is about measuring if the desired objectives were achieved. Project managers must think of project evaluation from the beginning by identifying what are the critical factors for success and what are the project milestones to get there. This must be written into the Scopes of Work, Requests for Proposals and contracts. Periodic analysis of whether the project is effectively meeting these critical factors and milestones is then done. A final evaluation of the project will analyze if the investment was worth the benefits it generated. It will also hold good lessons for future projects. Interviewees noted that it is difficult to do final project evaluations since no funds are allocated for it. Other interviewees noted that federal agencies could fund or perform the evaluations to ensure impartiality.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Analysis	Awareness			* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges
	Specialized			
Inspection and acceptance testing procedures, setting performance measures, quality assurance/quality control	Awareness			
	Specialized	◇ Workshop on setting ITS systems performance measures, and inspection and testing		
Project Evaluation	Awareness	✓ Transit Performance Evaluation: Using Information-Based Strategies	NTI	* Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, cost/benefit analysis after deployment		
Technology benefits and performance assessment	Awareness			
	Specialized	◇ Use of the CORSIM Computer Traffic Simulation Model ◇ Other planning models ✓ Intelligent Transportation Systems for Transit: Solving Real Problems ✓ Reinventing Transit: Planning Information-Based Transit Services ✓ Transit Performance Evaluation: Using Information-Based Strategies	U.S. DOT NTI NTI NTI	

Project Management: ITS requires more project/business management skills than in the past. In ITS, project management takes on the features of being multi-agency, multi-discipline, and multi-jurisdictional with a high technology orientation. This includes ensuring that the deployment project is coordinated with other ITS deployments occurring within the region and that consideration is given to the operations, maintenance, and evaluation of the systems in the planning and design stages. ITS project management highlights overcoming the institutional obstacles that exist, especially as networks connect agencies and data, and employees find their work environment evolving toward technological interdependency. As a result, ITS project management requires a mix of skills that broadly fall into the categories of managerial, technical, financial, strategic planning and evaluation.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Technical Management: managing the technical feasibility, and related issues such as extendability, expansion, or systems security; applying the principles of systems, electrical, and telecommunications engineering.	Awareness	◇ Workshop on writing ITS specifications		* Course on the software development process and software engineering offered by universities * Course on the principles of systems engineering offered by universities * Recommended reading: <i>Protecting Our Transportation Systems: An Information Security Awareness Overview</i> , FHWA-JPO-98-005 (EDL)
	Specialized			
Financial Management: managing the budgeting, accounting, tracking, and procurement efforts	Awareness	◇ Workshop on writing and using ITS contracts		* Course in public sector financial management: cost/benefit analysis, investment analysis, risk analysis, budgeting and accounting procedures, and use of Gantt charts offered by universities, junior colleges, and U.S. DOT
	Specialized			
Analysis	Awareness			* Courses in analysis: cost/benefit analysis, investment analysis, risk analysis offered by universities, professional associations or junior colleges
	Specialized			

(Project Management, cont' d)

Strategic Planning: coordination with other deployments and construction activities; coordinating cross-agency work; applying the principles of the National ITS Architecture.	Awareness	<ul style="list-style-type: none"> ✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards ✓ The National ITS Architecture: An Introduction for FTA Senior Staff ◇ Workshop on ITS Project Management 	FHWA FTA	<ul style="list-style-type: none"> * Course on project management from U.S. DOT, universities or junior colleges * Course on writing business plan/project plans from U.S. DOT, universities, or professional associations
	Specialized	<ul style="list-style-type: none"> ✓ Planning the Integration of Transit and Traffic ITS Applications ✓ Using the National ITS Architecture for Deployment —Public Sector ✓ Using the National ITS Architecture for Deployment —Private Sector ◇ Turbo Architecture 	NTI FHWA FHWA	
Management: managing contractors; building and managing intra-agency and inter-agency teams; obtaining appropriately qualified staff, possibly designing new positions; managing organizational change	Awareness	<ul style="list-style-type: none"> ✓ Public/Private Partnerships ✓ Procuring and Managing Systems Integrators ◇ Workshop on bridging public-private sector differences 	NHI ITS America	<ul style="list-style-type: none"> * Course in change management offered by business schools or universities * Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i>, FHWA-JPO-99-032 (EDL)
	Specialized			
Project Evaluation: setting performance measures; designing test and evaluation methodologies	Awareness	<ul style="list-style-type: none"> ✓ Transit Performance Evaluation: Using Information-Based Strategies 	NTI	<ul style="list-style-type: none"> * Recommended reading: Reports from ITS Federal Operational Tests and their evaluation strategies (search on the EDL)
	Specialized	<ul style="list-style-type: none"> ◇ Workshop on ITS project evaluation, setting performance measures, acceptance testing of devices and systems, cost/benefit analysis after deployment 		
Operations: planning for operations in the design stage; managing the transition from deployment to operations	Awareness	<ul style="list-style-type: none"> ✓ Operating and Maintaining ITS 	ITE	
	Specialized			

Operations: Deploying ITS technologies results in the ability to better operate and manage transportation systems to achieve safety, efficiency, better response time, and better mobility. The knowledge and skills involved in operations form a foundation for professionals to understand how the technologies, the network linkages and the personnel combine to form an ability to manage the transportation systems in real-time. This competency requires a certain level of success in deployment whereby institutional barriers are reduced and a new way of doing business is established. Based on this success, actual operations and management activities can proceed to achieve systems performance goals.

The tasks involved in operations must be considered and planned for in the planning and design stages of deployment.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Managing an operations center and/or a traveler information center	Awareness	✓ Operating and Maintaining ITS	ITE	* Courses in management including budgeting and scheduling from universities, junior colleges, and business schools
	Specialized			
Transportation and ITS operations	Awareness	✓ Deploying Integrated ITS- Metropolitan	NHI	* Systems engineering courses offered by vendors and universities
		✓ Deploying Integrated ITS- Rural	NHI	* Recommended reading: <i>Successful Approaches to Deploying a Metropolitan Intelligent Transportation System</i> , FHWA-JPO-99-032 (EDL)
	Specialized	✓ Planning the Integration of Transit and Traffic ITS Applications	NTI	
National ITS Architecture and Data sharing between agencies	Awareness	✓ An Introduction: National ITS Architecture and Interim Guidance on Conformity with Architecture and Standards	U.S. DOT	* Courses on National ITS Architecture, NTCIP, and ITS concepts offered by vendors
		✓ The National ITS Architecture: An Introduction for FTA Senior Staff	FTA	
	Specialized	◇ Turbo Architecture	U.S. DOT	
Partnerships and cross-agency teamwork	Awareness	✓ Public/Private Partnerships ◇ Workshop on bridging public-private sector differences	NHI	
	Specialized	✓ Procuring and Managing Systems Integrators	ITS America	

(Operations, cont' d)

Staffing, scheduling, and training	Awareness			<ul style="list-style-type: none"> * Course in human resource management including writing job classifications and staffing, offered by business schools and universities * Courses in training and presentations offered by universities, professional associations, and junior colleges * Courses in teaching with advanced technologies * Courses in Instructional Systems Design (ISD)
	Specialized			
Software Applications	Awareness			<ul style="list-style-type: none"> * Courses on software applications such as word processing, spreadsheets, databases, or internet applications offered by junior colleges, universities, agency training programs, professional associations or software vendors
	Specialized			
Data and database management and maintenance	Awareness			<ul style="list-style-type: none"> * Courses on building databases and relational databases offered by universities
	Specialized	<ul style="list-style-type: none"> ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Geographic Information Systems: Transit Applications 	NTI NTI	

ITS Legal Issues: ITS requires addressing legal issues such as intellectual property rights, data and broadcast content, and software & hardware sharing arrangements. These issues should all be addressed in the contract and MOU. Intellectual property rights considerations include making clear who owns the source code and modifications to it when a contractor develops software. *See Competency Category on Software Development.* It also includes licensing agreements for copyrights, trademarks and patents for products and services used and perhaps modified by an agency. Privacy issues are raised with data sharing amongst agencies and with the private sector. Detailed broadcast video of freeway incidents or a failure in traffic signal coordination that results in an accident can leave agencies open to liability. These issues must be addressed in contracts and MOUs to safeguard agency operations. Contracts should also include clauses for testing and prototyping of systems as well as warranties and guarantees for work completed. Changes in legislation may have to occur to allow for public-private partnerships and inclusion of these issues into contracts.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Contracts and procurement	Awareness	<ul style="list-style-type: none"> ◇ Workshop on writing and using ITS contracts and specifications ◇ Lessons Learned in ITS Procurement 	NHI	
	Specialized	<ul style="list-style-type: none"> ✓ Procuring New Technologies for Transit 	NTI	
ITS legal issues including liability and institutional risk	Awareness			<ul style="list-style-type: none"> * Recommended reading in ITS institutional and legal issues (search on the EDL) * Course in legal issues offered by the U.S. DOT * ITS America's Legislative Affairs web site: http://www.itsa.org/legislative.html
	Specialized	<ul style="list-style-type: none"> ◇ Seminar on ITS Legal Issues 		
Intellectual Property Rights/Copyrights/Patents	Awareness			<ul style="list-style-type: none"> * Course on Intellectual Property Rights, Copyrights and Patents from law schools *
	Specialized			
Cooperative Agreements/MOUs, compensation agreements	Awareness	<ul style="list-style-type: none"> ✓ Public/Private Partnerships ✓ Shared Resources for Telecommunications 	<ul style="list-style-type: none"> NHI NHI 	<ul style="list-style-type: none"> * Recommended reading: <i>PCB Shared Resources: Sharing Right-Of-Way for Telecommunications: Guidance on Legal and Institutional Issues</i>, FHWA-JPO-96-0015 (EDL)
	Specialized			

Marketing/Public Relations: Marketing and public relations has become a critical part in the management of ITS projects. The public needs to be aware of the changes resulting from projects and be encouraged to use ITS products and services. Politicians and decision-makers need to see the benefits of ITS projects to continue funding and consideration of additional ITS. Marketing ITS products and services begins with the selection of the most effective message, easily comprehended, that will motivate the public to use ITS and demonstrates its benefits. This message will be well packaged and distributed. Decisions on the best way to reach customers—through radio, television, bus advertisements, pamphlets, etc. are made. Agency approvals and clearances for marketing campaigns may be necessary. Suitable administrative and control procedures for effective operation of advertising, sales promotion, publicity, merchandising, and other communication activities, whether they be in-house or contracted out, may also have to occur. In addition, transportation officials must have good public relations skills in order to communicate with the public and politicians using “laymen’s terms” and not transportation jargon.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Marketing and public relations skills	Awareness			* Courses in marketing and public relations offered by universities and junior colleges.
	Specialized			
Marketing ITS to Agency Senior Decision Makers, and Appointed and Elected Officials	Awareness			* Recommended reading: * <i>Marketing ITS Infrastructure in the Public Interest</i> , FHWA-JPO-98-029 (EDL) * <i>Traveling with Success: How Local Government Use Intelligent Transportation Systems</i> , FHWA-JPO-96-009 (EDL) * <i>ITS Market Resource Guide: Federal, State, and Local Contacts in ITS</i> , ITS America.
	Specialized			
Marketing ITS to the Traveling Public and engaging the media	Awareness			◇ Case studies on the best practices and lessons learned from ITS deployment projects and engaging the media and traveling public
	Specialized			

Problem Solving: ITS requires recognizing and defining problems that arise during the stages of an ITS project. Issues arise due to the multitude of agencies and people involved in projects. Problem solving requires analyzing relevant information and looking at alternative solutions. Conflict management involves anticipating potential conflicts and resolving confrontations, disagreements, and complaints in a constructive manner when they do occur. This competency is about identifying and dealing with problems diplomatically and effectively.

Unlike the other competencies, it is not a bundle of knowledge and skills, but rather an ability to apply the skill of problem solving when applying the other competencies. To facilitate building problem solving capacity, the PCB program will focus future efforts on creating a series of hands-on initiatives. Workshops, labs and case studies are proposed to address needs related problem solving for the following topics:

- ⇒ Managerial/Administrative Skills: Managing contractors, negotiations, writing specifications, institutional issues.
- ⇒ Technical Skills: Equipment installation, maintenance, troubleshooting.

Systems Support & Maintenance: The Systems Support and Maintenance competency consists of a thorough knowledge of the computer hardware, operating systems, and application software. It is most often site-specific, so that the support person is able to install, maintain and troubleshoot both the in-house hardware and software. Given that ITS deployments have extensive computer systems that collect, organize and disseminate information to different agency departments as well as other agencies, Systems Support and Maintenance Technicians have added responsibilities for which further professional capacity building may be needed.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Network Administration	Awareness			* Course in systems administration including maintenance of servers, backing up servers, client account maintenance, repair and troubleshooting
	Specialized			
Software installation and updating	Awareness			* Course in systems administration that includes software installation, maintenance, upgrades, and troubleshooting
	Specialized			

Transportation Fundamentals: It was discovered in interviews that a basic grasp of transportation principles, both highways and transit, was critical for system integrators and software engineers to do transportation applications. This requires a basic understanding of the vocabulary and concepts common to transportation agencies, for example, “dwell time” (which refers to the length of time a bus spends on a given stop). Along with terminology and traffic concepts, one needs an understanding of the modal functions that drive the mission, design and operation of an agency’s system. This need was mostly expressed in context of consultant deficiencies. While many consultants are well versed in the design and installation of technologies, they lack knowledge on how their work solves transportation problems. This can prevent them from designing systems that most fully satisfy the needs of their clients. See Competency Category on Systems Analysis & Design. This competency is about ensuring that non-civil engineers are knowledgeable on how their work is being applied to transportation problems.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Traffic/Transit operations vocabulary	Awareness			* Course on the basics of transportation engineering to learn the vocabulary and fundamentals of traffic and/or transit offered by universities, transportation professional associations, or vendors
	Specialized			
Transportation planning basics	Awareness			* Course on the basics of transportation planning offered by universities
	Specialized			
Operations	Awareness	✓ Operating and Maintaining ITS	ITE	
	Specialized			
Intermodalism	Awareness			
	Specialized			

Legislative & Policy Change: ITS requires a good understanding of agencies' legislative authority in providing new transportation solutions. ITS projects such as HOV lanes and new revenue sources like video enforcement ticketing may require legislative changes to deploy. This involves identifying obstacles in state constitutions and laws as well as federal regulations that restrict the types of contracts and partnerships allowed. Jurisdictional boundary issues such as different procurement processes and contracting methods must also be addressed.

CRITICAL KNOWLEDGE AND SKILLS		Available Training/Education		
		From DOT PCB Catalog		Other Sources
		What	Access	
Promoting and marketing ITS to Senior Agency Decision Makers, and Appointed and Elected Officials	Awareness			
	Specialized			<ul style="list-style-type: none"> ◇ Case studies from agencies who worked with their state, regional, and local legislators and appointed officials to change policies to accommodate ITS * Course in negotiations offered by universities or junior colleges
Understanding the Political Environment and Policy Skills	Awareness			<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Traveling with Success: How Local Government Use Intelligent Transportation Systems</i>, FHWA-JPO-96-009 (EDL) * <i>ITS Market Resource Guide: Federal, State, and Local Contacts in ITS</i>, ITS America.
	Specialized			

Freeway Management Systems: Systems that provide information to motorists and detect problems to increase capacity, and minimize congestion caused by crashes.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ High Occupancy Vehicle Facilities ✓ Freeway Traffic Operations 	NHI NHI	<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Emissions Management Using ITS Technology</i>, FHWA-JPO-99-039 (EDL# 6325) * <i>Developing Freeway and Incident Management Systems Using the National ITS Architecture</i>, FHWA-JPO-98-032 (EDL)
Technologies	<ul style="list-style-type: none"> ✓ Traffic Control Software and Signalization 	NHI	

Incident and Emergency Management Systems: Systems that enable communities to identify and respond to crashes or breakdowns with the best and quickest emergency services, thereby minimizing clean-up time. Coordinated emergency response ensures that the closest available and most appropriate emergency response unit can respond to a crash.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept and Technologies	✓ Incident Management	NHI	* Recommended reading : * <i>Enhancing Public Safety, Saving Lives: Emergency Vehicle Preemption</i> , FHWA-JPO-99-002 (EDL #6871) * <i>Speeding Response, Saving Lives: Automatic Vehicle Location Capabilities for Emergency Services</i> , FHWA-JPO-99-003 (EDL# 6866) * <i>Faster Response Time, Effective use of Resources: Integrating Transportation Systems and Emergency Management Systems</i> , FHWA-JPO-99-004 (EDL# 6874) * <i>Improving Mobility, Saving Lives: Safety Service Patrols</i> , FHWA-JPO-99-005 (EDL #6872) * <i>Safer Travel, Improved Economic Productivity: Incident Management Systems</i> , FHWA-JPO-99-006 (EDL# 6868) * <i>Sharing Resources, Coordinating Response: Deploying and Operating Incident Management Systems</i> , FHWA-JPO-99-007 (EDL #6869) * <i>ITS Field Operational Test Cross-Cutting Study: Emergency Notification and Response</i> , FHWA-JPO-99-033 (EDL# 6326) * <i>ITS Field Operational Test Cross-Cutting Study: Incident Management: Detection, Verification, and Traffic Management</i> , FHWA-JPO-99-034 (EDL# 6328) * <i>ITS Field Operational Test Cross-Cutting Study: Hazardous Material Incident Response</i> , FHWA-JPO-99-035 (EDL# 6327)

Advanced Traveler Information Systems: Also known as regional multimodal traveler information systems. They are systems that provide road and transit information to travelers, businesses and truckers, so that they can more effectively plan their travel.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			* Recommended reading: * <i>ITS Field Operational Test Cross-Cutting Study: Advanced Traveler Information Systems</i> , FHWA-JPO-99-038 (EDL# 6323) * <i>Developing Traveler Information Systems Using the National ITS Architecture</i> , FHWA-JPO-98-031 (EDL)
Technologies			

Advanced Public Transportation Systems: Updated transit management systems that allow new ways of monitoring and maintaining our Nation's sizable transit fleets through advanced vehicle locating devices, equipment monitoring systems, vehicle diagnostics, and fleet management systems.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ ITS in Transit ✓ ITS Transit Management ✓ Intelligent Transportation Systems for Transit: Solving Real Problems ✓ Transit Performance Evaluation: Using Information-Based Strategies ✓ Reinventing Transit: Planning Information-Based Transit Strategies ✓ Planning the Integration of Transit and Traffic ITS Applications 	<ul style="list-style-type: none"> FTA FTA NTI NTI NTI NTI 	<ul style="list-style-type: none"> * Recommended reading: * <i>Better Service, Safer Service: Transit Management for Fixed-Route Systems</i>, FTA.TRI.10.98.1 (EDL# 6875) * <i>Better Service, Greater Efficiency: Transit Management for Demand Response Systems</i>, FTA.TRI.10.98.2 (EDL# 6876) * <i>National ITS Architecture Transit Guidelines</i>, FHWA-JPO-97-0016 (EDL) * <i>Review of and Preliminary Guidelines for Integrating Transit into Transportation Management Centers</i>, DOT-T-94-25 (EDL) * <i>Advanced Public Transportation Systems: The State of the Art Update of '98</i> FTA-MA-26-7007-98-1 (EDL) * <i>Advanced Paratransit Systems: An Application of Digital Map, Automated Vehicle Scheduling, and Vehicle Location Systems</i>, UCB-ITS-RR-97-1 (EDL)

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Technologies	<ul style="list-style-type: none"> ✓ Procuring New Technologies for Transit ✓ Geographic Information Systems: Transit Applications ✓ Analytic Troubleshooting for the Advanced Technology Bus: Train-the-Trainer ✓ NTI Fellows Workshops on Advanced Technologies and Innovative Practices for Transit 	NTI NTI NTI NTI	* Recommended reading: <i>FTA National Transit Geographical Information Systems Guidelines, Standards, and Recommended Practices</i> , DTRS57-95-P-80861 (EDL)

Advanced Traffic Signal Control Systems: Modernized traffic signal control systems that automatically adjust themselves to optimize traffic flow.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ Computerized Traffic Signal Systems ✓ Traffic Control Software and Signalization 	NHI NHI	* Recommended reading: <i>Developing Traffic Signal Control Systems Using the National ITS Architecture</i> , FHWA-JPO-98-026 (EDL)
Technologies	<ul style="list-style-type: none"> ✓ Advanced Traffic Signal Controller 	NHI	

Electronic Fare Payment Systems: New systems that enable a person to pay for parking, bus and train fares, and tolls by using a single smart card.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			* Visit ITS America' s web site: http://www.itsa.org/payment.html
Technologies			

Electronic Toll Collection Systems: Systems that provide drivers and transportation agencies with convenient and reliable automated transactions. This will dramatically improve traffic flow at toll plazas and increase the operational efficiency of toll collecting.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			<ul style="list-style-type: none"> * Visit ITS America' s web site: http://www.itsa.org/payment.html * Visit a private sector web site for information: http://www.ettm.com
Technologies			

Highway-Rail Intersection Systems: Advances in railroad crossings that are coordinated with traffic signals and train movements, and that notify drivers of approaching trains through in-vehicle warning systems.

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept			
Technologies			

Commercial Vehicle Operations/CVISN: Electronic systems and networks that allow for simple, cost-effective, and seamless exchange of safety and administrative data, electronic business transactions, and information on commercial vehicle operations and processes. There are four areas of applications to CVISN:

- **Safety assurance programs and services** designed to assure the safety of commercial drivers, vehicles and cargo. These include automated roadside safety inspections and carrier reviews, safety information systems, and onboard safety monitoring.
- **Credential administration programs and services** designed to improve the deskside procedures and systems for managing motor carrier regulation. These include electronic application, purchase and issuance of credentials, as well as automated tax reporting and filing.
- **Electronic screening systems and services** designed to facilitate the verification of size, weight and credential information. These include the automated screening of commercial vehicles at fixed weigh stations and international border crossings.
- **Carrier operations activities and services** designed to reduce congestion and manage the flow of commercial vehicle traffic, such as travel advisory and hazardous materials incident response services. The private sector is taking the lead in implementing fleet and vehicle management technologies and systems that improve motor carrier productivity.

(Commercial Vehicle Operations/CVISN, cont' d)

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ✓ ITS/CVO Program Management ✓ ITS/CVO Basic Awareness Course ✓ ITS/CVO Executive Briefing Session ✓ Introduction to ITS/CVO ✓ ITS/CVO Technical Project Management for Non-Technical Managers 	NTC NTC NTC NTC NTC	* Recommended reading: * <i>Improved Enforcement, Safer Roads for State Agencies: Commercial Vehicle Electronic Screening</i> , FHWA-JPO-99-008 (EDL# 6873) * <i>Achieving Shared Efficiencies Through Cooperative Implementation: Commercial Vehicle Electronic Screening</i> , FHWA-JPO-99-009 (EDL# 6867) * <i>Safer Trucks, Higher Profits for Motor Carriers: Commercial Vehicle Electronic Screening</i> , FHWA-JPO-99-010 (EDL#6870) * <i>ITS Field Operational Test Cross-Cutting Study: Commercial Vehicle Operations —Roadside</i> , FHWA-JPO-99-036 (EDL# 7863) * <i>ITS Field Operational Test Cross-Cutting Study: Commercial Vehicle Administrative Processes</i> , FHWA-JPO-99-037 (EDL# 6324)
Technologies	<ul style="list-style-type: none"> ✓ Understanding ITS/CVO Technology Applications 		

Rural ITS systems: ITS services and applications that are applied to meet the transportation needs of rural areas and small towns, travelers on rural roads, and in the National Highway System. Some rural systems will be extension of metropolitan and CVISN systems, applied to specific rural needs. Other applications are uniquely developed for rural needs. Services that characterize rural ITS are:

- **Traveler safety and security technologies** that alert drivers to hazardous conditions and dangers, and include wide-area information dissemination of site-specific safety advisories and warnings.
- **Emergency services technologies** that automatically mobilize the closest police, ambulances, or fire fighters in cases of collisions or other emergencies—even in the most remote locations.
- **Tourism and travel information services** that provide information to travelers who are unfamiliar with the local rural areas. These services can be provided at specific locations, en route, or well in advance of the traveler's destination.
- **Public traveler and mobility services** that improve the efficiency of transit services and their accessibility to rural residents. Advanced vehicle locating devices and communications systems can help achieve better scheduling, improved dispatching, smart card payment transactions, and advanced ridesharing and ride-matching systems.
- **Roadway operations and maintenance technologies** that improve the ability of our highway workers to maintain and operate rural roads. These include severe weather information systems, early detection of pavement and bridge failures, and immediate detection of dangers to work zone crews.
- **Fleet operations and maintenance systems** that improve the efficiency of rural transit and other rural fleets, such as snowplows and even law enforcement vehicles, through advanced vehicle tracking and on-board equipment monitoring systems.
- **Commercial vehicle systems** that manage the movement and logistics of commercial vehicles in rural settings, and locate them during emergencies and breakdowns. These include applications to improve safety, such as warnings associated with slow-moving vehicles, and scheduling applications for harvest season when vast numbers of trucks are needed during a very small time window.

(Rural ITS systems, cont' d)

CRITICAL KNOWLEDGE AND SKILLS	Available Training/Education		
	From DOT PCB Catalog		Other Sources
	What	Access	
Concept	<ul style="list-style-type: none"> ◇ Workshop that bridges the gap between weather information and transportation needs —what is currently available from the Weather Services ✓ Incident Management 	NHI	<ul style="list-style-type: none"> * Course on fleet management systems available from vendors * Recommended reading: <ul style="list-style-type: none"> * <i>Saving Lives, Improving Transportation Efficiency: Weather Information for Surface Transportation</i>, FHWA-JPO-99-015 (EDL# 6863) * <i>Rural Intelligent Transportation Systems Program Plan</i> (EDL) * <i>Rural Intelligent Transportation Systems Strategic Plan</i> (EDL)
Technologies			<ul style="list-style-type: none"> * Recommended reading: <ul style="list-style-type: none"> * <i>Technology in Rural Transportation: Simple Solutions</i>, FHWA-RD-97-108 (EDL) * <i>Rural Public Transportation Technologies: User Needs and Applications, Executive Summary</i>, FHWA-RD-98-126 and <i>Final Report</i>, FHWA-RD-98-125 (EDL)

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APPENDIX F: REPORT

BUILDING PROFESSIONAL CAPACITY IN ITS: GUIDELINES FOR DEVELOPING THE FUTURE TRANSPORTATION PROFESSIONAL

BUILDING PROFESSIONAL CAPACITY IN ITS:

GUIDELINES FOR DEVELOPING THE FUTURE PROFESSIONAL



US Department of Transportation
ITS Joint Program Office
ITS PCB Program

April 1999

Foreword

This report summarizes a comprehensive effort conducted in the summer of 1998 to more systematically investigate the intelligent transportation systems (ITS) training and education needs of transportation professionals. A team of analysts conducted a series of nearly 200 interviews in an effort to obtain a more detailed understanding of the underlying fundamental knowledge and skills required in support of ITS applications and services. The interviewees spanned a range of ITS involvement from those actively engaged for several years, to those just beginning the process. Thus, the reported needs reflect an important “grass -roots” perspective obtained from the public -sector, private-sector, and the academic community.

This report documents the wide -ranging ITS training and education needs of transportation professionals. An analysis of those needs resulted in the development of a PCB Program strategy to meet those needs both now and in the future. Although the focus of this work is ITS, the analysis also revealed that the fundamental knowledge and skills are applicable to a wider audience of transportation professionals engaged in the operation and management of multimodal surface transportation systems.

The ITS PCB Program is comprised of a partnership of organizations which work cooperatively to provide ITS professional capacity building. That partnership encompasses the public sector, the private sector, and the academic community. It is hoped that this report will be used as a foundation for ongoing dialogue with the multiple partners, stakeholders and transportation professionals everywhere about:

- The process of building professional capacity for ITS;
- The design and delivery of training and education programs that achieve the level of competency required for meeting the challenges of 21st century transportation systems; and
- The most effective and cooperative programmatic ways to meet training and education needs in ITS.

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ITS Joint Program Office, Washington D.C.
April, 1999

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- The Volpe National Transportation Systems Center (VNTSC)
- The Federal Transit Administration's ITS Program
- The Federal Highway's National Highway Institute (NHI) and Office of Personnel and Training.

The VNTSC project director was Suzanne M. Sloan, assisted by Mary Susan Sparlin of NHI. Key staff support from the Volpe Center was provided by Robert Brodesky, Joseph LoVecchio, Maureen Luna-Long, John O'Donnell, Douglas Rickenback, and Margaret Zirker.

The authors wish to thank the many individuals, located across the country, who took the time and made the substantial effort to arrange for the staff interviews that were so critical to this effort. Also, thanks is gratefully extended to the nearly 200 interviewees and the training and education experts who were willing to be interviewed and whose excellent contributions of information and guidance have greatly benefited our work.

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INTRODUCTION

This report presents a set of guidelines and recommendations for developing the “future transportation professional.” The introduction of intelligent transportation systems (ITS) technologies to transportation broadens the focus from the building and expansion of physical infrastructure, to include the operation and management of existing infrastructure with newly developed high -technology tools and applications. This expansion changes the skill set required of transportation professionals.

A series of nearly 200 interviews with current transportation professionals, conducted in the summer of 1998, helped identify a set of competencies recommended for the next generation of transportation professionals. In particular, ITS requires skills that venture beyond the borders of traditional civil engineering to include a technical breadth and depth in information, sensing, and computer technologies; systems, telecommunications, and electrical engineering; and in the design and installation of new ITS applications. It also requires a broader understanding of institutional issues such as interagency cooperation, coalition building, and public and private sector partnerships, necessitating new skills in partnering, contracting and negotiations, applying new business and organizational skills, and enhanced verbal and written communications skills. In addition to increased technical and institutional breadth and depth, future transportation professionals will need to operate and manage from a systems perspective.

These new competencies tend to be in addition to the ones already required in formal degree programs; thus, academic institutions face the challenge of how to provide the required foundation with an additional high -technology focus to prepare students to be 21st century transportation professionals.

The intended audiences for this report are faculty, students, and others who are developing future professionals for the 21st century. Guidelines and recommendations are presented in three parts:

- The first section presents the essential characteristics of future professionals who will be engaged in ITS and the operation and management of transportation systems.
- The second section recommends actions to a range of educational institutions and audiences — from K-12 to technical and vocational schools to universities and colleges.
- The third section recommends actions for the U.S. DOT PCB Program and its partners to assist in developing future professionals.

Appendix A presents a series of brief summaries of the reports and articles included in the literature review. Readers who are interested in a more academic treatment should review these.

Appendix B provides the bibliography.

Supporting Documentation

This report is one in a series of reports presenting ITS training and education needs of transportation professionals. The primary report, for which the needs assessment was conducted, is titled, *Building Professional Capacity in ITS: Documentation and Analysis of Training and Education Needs in Support of ITS Deployment*. This report on future professionals is included as an appendix to this broader report, in addition to being issued as a stand alone document.

In addition, there are two companion guideline reports that emerged from this broader effort (and are also appendices to the primary report). They are:

- *Building Professional Capacity in ITS: Guidelines for Designing an Individualized Training and Education Plan*, is a guide for transportation professionals who are interested in building their own professional capacity in ITS.
- *Building Professional Capacity in ITS: Guidelines for Staffing, Hiring, and Designing Ideal ITS Project Teams*, is a guide for decision makers who are responsible for staffing, hiring, and designing project teams for ITS. These decision makers must consider not only the competencies of current staff, but also anticipate the qualifications of future staff and/or of team members from other agencies. This guide presents strategies and programs for building and maintaining organizational professional capacity.

In addition, a set of transit specific findings and recommendations are highlighted in a separate report titled:

Building Professional Capacity in ITS: An Assessment of ITS Training and Education Needs — The Transit Perspective.

All of these reports are posted to the ITS PCB Program web site (www.its.dot.gov/pcb/pcb.htm) and the ITS Electronic Document Library (<http://www.its.dot.gov/welcome.htm>).

Section I – Characteristics of Future Transportation Professionals: Interview Findings

The transportation professional of the future will be required to have both breadth in several disciplines, and depth in a number of specific areas. A series of ITS site interviews, focus groups, and telephone interviews revealed a need for a new cadre of professionals. Current transportation professionals indicated that their priority when hiring is to seek candidates who are electrical engineers with knowledge of telecommunications and transportation. Managers look for civil engineers with some depth in electrical engineering and computer science. Managers also look for candidates with management and business skills and excellent interpersonal and communications skills. Interviewees also noted that often the most valuable skills are adaptability and creativity, coupled with the ability to apply them to practical, real-world needs. Many agencies said they would rather hire someone with a broad education and practical experience, than a person with an advanced degree with little real-world experience. However, such individuals are not only difficult to find but also difficult to retain if hired, given the competition from the private sector.

As part of the interviews, participants were given a survey and asked to indicate which knowledge and skills they deemed most important for ITS. The following is a summary of specific topics that were proposed, by current professionals, as critical to the transportation professional of the future:

Systems Integration — This essential competency requires the recognition that a comprehensive regional transportation system is made up from a number of individual projects carried out by a variety of transportation organizations. The “system” encompasses all of the individual projects, even though each is complete and functional in its own right. On a more detailed level, systems integration refers to the specific components or devices required by the individual projects and how they are related. Each device’s internal performance, its communication links to other devices, data input/output or manipulation, and control mechanisms are part of a complex chain with many potential “weak links.” The devices must work properly and communicate accurate and timely information to be of practical use. Specific knowledge of the various technologies and their application is necessary for this purpose.

Managing Contractors — ITS deployments require management skills not found in traditional government-contract relationships. Since managing outside contractors is such an important part of most ITS deployments, it is especially important to understand both the contractor and the public sector agency point of view. The ability to manage contractors requires continual support throughout the deployment process. It starts with the writing of good functional specifications for the “request for proposals,” and continues to the development of detailed contract documents that are clearly stated and understood. A sound knowledge of scheduling using Gantt charts and budget management is also important.

Contracting Options — Contracts outline a schedule of deliverables defined for a specific project. Given the intricacies of advanced technology procurements, it is important that transportation officials know alternative types of deployment contracts such as design/build, low-bid, fixed price as

well as special clauses to be included in contracts. Examples of the latter include clauses specifying responsibility and liability of involved partners, clarification of software and hardware sharing issues between States and other jurisdictions, source code ownership, acceptance testing and operability, warranties, and inclusion of training and performance standards.

Software/Hardware Specifications — Software is a critical component of virtually all ITS projects. Interviewees noted that they would like to know the basics of writing code and how computers talk to each other using local area networks and wide area networks. They would also like a more detailed understanding of software programs and relational databases. Since hardware must be carefully selected to be an efficient platform for the desired software, knowledge of hardware device options is important.

Project Management — Project management requires the ability to take a project from its early conception stages to completion. It includes creating “requests for proposals” that adequately reflect end-user needs, scheduling and financially managing both staff and contractors, particularly individuals with strong ITS-related technology based expertise. A sound knowledge of data management and its usage in data sharing arrangements with other transportation agencies is also important. Excellent communication and facilitation skills are crucial.

Data Management — The proliferation of data collection devices, the need for public agencies to continually deliver “more for less”, and the advances in database technology create a situation where so much information is available that it can often be overwhelming. The essence of many ITS devices is the data they produce; and the value of the system is closely related to how that data is used. Effective data management involves many issues such as data consistency and accuracy, data sharing with other agencies, compatibility and conversion to other systems, data archiving and storage, analysis and interpretation of data, and privacy. Knowledge of database design, manipulation, and data import/export is needed.

Data Evaluation — Data evaluation requires determining the effectiveness of a program and identifying where improvements can be made. For example, traffic speed and volume data evaluation is particularly needed on the highway side. Schedule planning and fleet data evaluation is needed on the transit side. Strong statistical and analytical skills are needed to undertake these activities.

Section II – Recommendations: Suggestions and Activities for Implementing Change

Ideally, recent college or university graduates would come to the job with fundamental education skills, ready to hit-the-ground-running. In practice, this would be too much to hope for and impossible to achieve. Interviewees made numerous suggestions that included curriculum changes in undergraduate and graduate civil engineering programs (the predominant source of transportation professionals) to incorporate concepts in electrical engineering, telecommunications technologies, systems

engineering, software development and basic electronics. Several interviewees recommended that a course on project management be included with emphasis in economics, business, public agency organization, and the political process. Also, in an ideal world, electrical engineering and computer science majors interested in transportation would take a "Transportation 101" course that included fundamentals in traffic engineering and transportation systems analysis, so that these professionals could see how their skills apply to transportation problems.

Based upon the current field interviews and previous studies the following recommendations for actions are offered. They are divided into the following seven categories:

1. Pre-college programs
2. Community and junior college programs, and technical schools
3. Undergraduate programs
4. Graduate programs
5. Continuing education programs
6. Educating the educators
7. Innovative delivery media

1. PRE-COLLEGE PROGRAMS

Although not necessarily included in a substantive or explicit way in previously referenced work, there is continuing concern that the industry must appeal to the interests of young people at an early stage in the education process in order to attract them to the transportation profession. A recent study sponsored by the American Society of Civil Engineers (see Appendix B) found that the average American feels uninformed about the engineering enterprise, and has very little understanding of the significance and importance of the engineering discipline. Further, there is a limited understanding of the role of science and technology and its impact on society. The transportation profession, being just one of the individual engineering disciplines, is just as likely to be misunderstood or overlooked by young people who are thinking about a career.

Current Activities

There are several national programs available to help fill that void, which should be expanded upon and nurtured by the profession. Two of note are the:

- Garrett A. Morgan program, sponsored by U.S. DOT
- the Transportation Civil Engineering Research Activities Centers (TRAC) program, sponsored by U.S. DOT and the American Association of State Highway and Transportation Officials.

Another example is the Texas Transportation Institute (TTI) program for cultivating new professionals early. In conjunction with the Southwest University Transportation Center, TTI has launched a pilot program to develop educational and outreach materials designed to target age groups from kindergarten to high school seniors. In addition to materials and internet access, the program includes classroom visits as well as tours of local transportation facilities and traffic management centers.

2. COMMUNITY AND JUNIOR COLLEGES AND TECHNICAL SCHOOLS

These institutions play an essential role in developing future professionals for ITS. First, there is and will continue to be a demand for many categories of highly skilled technicians such as electronic maintenance technicians or system operators. Education programs must be established to expand that pool of talent. Second, these institutions could instill an interest in transportation among students who might not otherwise recognize the opportunities provided by the transportation profession. This could lead to increased enrollments in four-year undergraduate transportation programs.

Finally, these institutions provide an excellent venue for continuous education for professionals in specific technical areas. However, such events will not take place without a concerted effort to facilitate and encourage such actions by the public sector, the private sector, and the academic community.

Current Activities

A number of community and junior colleges offer transportation or related programs for future professionals. However, our research did not explore this important topic further.

3. UNDERGRADUATE PROGRAMS

The findings of the interviews and literature review reveal that undergraduate transportation programs need to be carefully re-evaluated to consider the new challenges being faced by transportation professionals. Each university will no doubt continue to debate these issues for some period of time; a number of experimental programs will no doubt be carried out. The previous insights on competencies viewed as essential by current practitioners, together with several recommendations made by noted academicians lead to the following suggested curriculum guidelines to consider at the undergraduate level:

Fundamentals

- Basic mathematics and science
- Systems engineering concepts
- Advanced materials
- Advanced sensors
- Modeling
- Computer software
- Computer hardware
- Information technologies
- The interrelationship between technology and society
- Economics and business analysis.

Electives – Essential Non-Technical

Skills

- Oral and written communications
- Project management
- Social, environmental impacts, public-private relationships
- Political science
- Planning
- Interpersonal relations.

- **Other bachelor-degree level programs.** Traditionally, a majority of transportation professionals have come from the civil engineering profession. However, in recent years, and particularly in those instances where ITS deployment is moving ahead rapidly, other disciplines have become essential. They include electrical engineering, computer sciences, systems engineering, mechanical engineering, and information technology. In addition, it has become apparent that many non-technical disciplines are required as well. They included human factors, planning, environmental analysis, economics, political science, and legal expertise.

There is no doubt that it would be difficult to incorporate “transportation” courses into those non-engineering disciplines, unless an individual were particularly interested in the topic. However, in these cases, training in basic transportation systems would be desirable in order to groom individuals to the tasks to be undertaken. To accomplish this objective, cooperative inter-departmental programs would be required within the university environment.

It is recognized that to address all these areas in a period of four years represents a challenge for the educational community. Many will argue that the time is too short and that five or more years are needed. As seen from the field interviews of ITS professionals, graduates from universities, after spending several years in the field may discover that there are subject areas for which they lack specific training. They may reflect on their undergraduate education and conclude that additional courses should have been offered to meet specific work related requirements they now face. However, the undergraduate experience should be viewed as preparation to begin a professional career (where more in-depth training will be required) or to pursue graduate study as a way of developing more depth in particular areas. Thus, an appropriate balance must be found.

- Finally, opportunities must be established to undergraduate students to help provide practical on-the-job training as part of internships, cooperative education programs, summer jobs, applied research projects and mentoring programs. Closer partnerships with government agencies and the private sector will assist undergraduates in relating fundamental knowledge to real-world issues. This could be established through work-study programs and applied research projects.

Current Activities

Some universities have already embarked upon the kinds of modifications suggested above with a focus in three areas:

- Incorporation of ITS knowledge and skills into existing coursework.
- Development of full semester ITS education modules/courses.
- Restructuring of undergraduate degree curricula.

Virginia Tech’s Center for Transportation Research, in cooperation with U.S. DOT’s ITS PCB Program, recently published a catalog of university ITS offerings titled , *Intelligent Transportation Systems Education and Training Efforts at U.S. Universities: Course Catalog*. In three parts, it lists **Full Semester ITS Courses; Short Courses, Workshops, and Other ITS Offerings; and Courses Modified to Include ITS Concepts**. It can be accessed on the Virginia Tech’s Center for Transportation Research web site at: www.ctr.vt.edu/catalog/toc.shtml.

4. GRADUATE LEVEL PROGRAMS

A number of universities have already begun the process of modifying existing graduate courses in transportation, and developing new degree programs. The following section provides some examples of these programs. There are other significant developments in graduate level programs, either in place or being considered. This is being addressed by the Council of University Transportation Centers

Another view on this topic was presented recently by the American Society of Civil Engineers (ASCE). In a recently published article, the ASCE Board of Directors approved a new policy statement supporting the concept of the Master's degree as the first professional degree for the practice of Civil Engineering. That body stated, "The Civil Engineering Profession is undergoing significant, rapid and revolutionary changes, demanding a much higher level of knowledge and experience of new engineers than of previous generations.....Today's engineers must have skills in computer applications, information technology, management, communications and foreign languages, as well as fundamental engineering skills. They must also grasp the political, economic and social implications of projects." The above recommendations from the ASCE Board of Directors were not focused on Intelligent Transportation Systems. Rather, they applied to the entire Civil Engineering profession, which traditionally has included transportation as a major discipline.

The significant connection here is that the findings from the field interviews support the recommendations for both under graduate and graduate level programs discussed above. It is hoped that the identification of the competencies required for ITS provide the more detailed guidance needed by universities to develop programs best suited for their specialty areas. These competencies are found in more detail in the report, *Building Professional Capacity in ITS: Documentation and Analysis of Training and Education Needs in Support of ITS Deployment*.

Current Activities

A number of universities are pursuing changes as the ones described above. One example is the University of Michigan which is in the process of establishing a new two -year "Masters of Engineering in Transportation." It is an interdisciplinary degree program in the College of Engineering having five focus areas and four requirements:

Five Focus Areas	
(1) Vehicles	<ul style="list-style-type: none">• Mechanical Engineering• Aerospace Engineering
(2) Physical infrastructure	<ul style="list-style-type: none">• Civil Engineering
(3) Information technology	<ul style="list-style-type: none">• Electrical Engineering
(4) Human factors	<ul style="list-style-type: none">• Industrial and Operations Engineering• Ergonomics
(5) Systems	<ul style="list-style-type: none">• Industrial and Operations Engineering• Electrical and Systems Engineering• Civil Engineering

Four Requirements	
Depth	Course requirement satisfied by courses taken in the major focus area or sub-area;
Breadth across engineering	Course requirement satisfied by introductory course and engineering courses taken outside of the major focus area;
Breadth beyond engineering	Course requirement satisfied by Mathematics, Statistics, Urban and Regional Planning and other courses
Team project experience	Industrially relevant team project requirement.

Other universities are pursuing similar activities to establish new degree programs or restructure established programs to reflect the inter-disciplinary nature of the job market.

5. CONTINUING EDUCATION PROGRAMS

It is very clear that continuing education programs at the college and university level are an essential part of ITS professional capacity building. There are several compelling reasons for this need:

- As stated earlier, the bachelors degree in any professional discipline must be viewed as only the first stage of a continuous learning process for all professionals. The same is true for the masters level, even though this is in a specialty area. Technological change, environmental and social change, and all the elements of current society are rapidly evolving. Thus, every professional needs to take advantage of continuing education programs to stay current in all professional disciplines.
- Continuing education programs can be designed to eventually lead to graduate programs in many areas. This provides motivation for individuals, and opportunities for universities.
- Colleges and universities have much more flexibility in designing new programs for busy professionals and are thus well-equipped to address many of the new demands for education suggested in this chapter.
- Building upon the competencies required for ITS deployment, universities can offer training for current professionals in critically needed areas. This provides just-in-time delivery to meet current needs.
- Potential students need tailored courses of study to meet their own individual needs. Continuing education programs can be designed to be flexible enough to deal with changing demand and immediate needs.
- Certificate programs can be established to provide students with specific skills needed to plan and deploy surface transportation projects.

Current Activities

Numerous universities are now engaged in these activities. For instance, Penn State University has worked closely with Penn DOT to offer continuing education courses for a number of years. A number of other universities around the nation offer similar programs in conjunction with their state DOTs. Also, FHWA sponsors the Local Technical Assistance Programs (LTAP). The LTAP serves as the primary channel through which innovative transportation technology is prepared and delivered to urban and rural communities throughout the United States. There are 57 centers (one in each state, one in Puerto Rico and six for American Indian tribal governments) that provide training and technical assistance to local government. Each center is a partnership of federal, state, and local agency resources as well as universities and the private sector. More information can be found at the web site: www.ota.fhwa.dot.gov/about/ltapover.html.

6. EDUCATING THE EDUCATORS

College and university faculty engaged in directly related research programs are in an ideal position to bring up-to-date research results into the classroom. This is one of the best ways to remain current and to transfer technology to the classroom.

However, not all universities are research-oriented. Thus, it may be difficult for faculty members to keep up-to-date on the latest technological and related developments. This leads to the conclusion that targeted education programs need to be designed specifically for faculty during summer or sabbatical leaves. This is a new challenge that can be addressed by the U.S. DOT Professional Capacity Building program. But, it can also be addressed by encouraging the private sector to work closely with universities through cooperative application of transportation programs.

Current Activities

This happens now through conferences and workshops. This is a topic worthy of more discussion.

7. INNOVATIVE DELIVERY MEDIA

There is clearly a need for education to be delivered by a combination of available media, including:

- Traditional classroom
- Distance learning via satellite or teleconference
- Web-based
- CD ROM-based

Individuals need “just-in-time” delivery of training, education, technical assistance and information required to do their jobs. Distance learning media provide the tools necessary to deliver and meet those needs.

Current Activities

Many universities are now actively developing distance learning in order to deliver courses, certificate programs, continuing education programs, and degree-granting programs. This is a growing trend throughout the Nation. More information on distance learning for ITS education can be found in the report, *Building Professional Capacity in ITS: Documentation and Analysis of Training and Education Needs in Support of ITS Deployment*.

Summary and Conclusions

Recommendations on how to prepare transportation professionals for the 21st century are not new or startling; it is important to note that those made by practitioners in the field are very consistent with the recommendations made by several prominent academicians whose work is summarized in Appendix A. However, the results of the field interviews do highlight several important directions to consider:

- *Education must be a continuous, lifelong endeavor.*
- *Attracting bright young people to transportation* and educating the transportation professionals of the future should begin well in advance of the college years.
- *Education programs must be viewed in a comprehensive way*, that consider community and junior colleges, technical schools, undergraduate and graduate programs, continuing education programs and new delivery media.
- Given the rapid advances in transportation technology, *programs must be established for transportation faculty and working transportation professionals* to assist them in keeping up-to-date.
- *The need for more comprehensive courses and programs at the college and university level* is a growing concern for both the “operations” segment and the “infrastructure” segment for undergraduate transportation programs. Those programs are already burdened with increasing demands for more information to be incorporated in existing courses or in new courses. This is a significant constraint that must be addressed. However, it appears that there are common needs in technology requirements that are applicable to both transportation infrastructure and operations purposes. The challenge is to identify these common needs.

Section III – Role of the ITS PCB Program: Recommendations and Actions for Supporting Change

The ITS PCB Program has an important role in helping to meet these goals. The ITS PCB Program is comprised of a collaboration of many organizations which bring different strengths and expertise to bear on building ITS professional capacity. The PCB partners are drawn from the private sector, the public sector, and the nation’s universities to develop and deliver the comprehensive, national transportation training and education initiatives required to create the transportation professional of the 21st century.

ITS PCB Program Partners

Public Sector Organizations	Academic Institutions	Private Sector Organizations
<ul style="list-style-type: none">• The ITS Joint Program Office• The U.S. DOT ITS PCB Program• FHWA and NHI• OMC and NTC• FTA and NTI• ITS America (ITSA)• Non-profit professional associations• State and local programs	<ul style="list-style-type: none">• Undergraduate degrees at universities and colleges• Graduate degrees at universities and colleges• Continuing education• Community colleges• Technical and vocational schools• Pre-college programs	<ul style="list-style-type: none">• Private sector training organizations• Vendors of ITS equipment• Consultants and corporations in the deployment, systems integration, and operations business• Professional associations with private sector membership

Role of the U.S. DOT PCB Program

The role of the U.S. DOT's program has been to establish partnerships among other organizations, and to define critical topics in ITS professional capacity building, namely:

- The full range of competencies needed for ITS deployment;
- The initial course and seminar offerings for ITS professional capacity building; and
- The preliminary definition of the role of PCB partner organizations.

The U.S. DOT's ITS PCB Program has also accomplished the following to address the needs of future transportation professionals:

- Helped to organize and support the organization of two forums to discuss the role of universities in ITS professional capacity building, one at ITS America in February 1997 and one at the Transportation Research Board's (TRB) Annual Meeting in January 1999.
- Provided matching funding to a university to develop the university catalog.
- Leveraged funding to cost-share on the development of future ITS distance learning initiatives.

It is important that this and the other PCB guideline reports be used as the foundation for ongoing dialogue with the PCB partners. We will continue to work with the universities to help achieve our mutual goals.

Role of Academic Institutions

Academic institutions — Universities and Colleges, Continuing Education Programs, Community/Junior Colleges and Technical/Vocational Schools — are partners that bring research strengths and teaching expertise to building ITS professional capacity in future professionals. They have and will continue to play a critical role in a wide variety of program activities such as:

- Develop and/or update professional capacity building materials and programs for current professionals; Integrate PCB materials into courses and degree programs for future professionals.
- Deliver ITS professional capacity building to target audiences (working professionals and future professionals) using the ITS "model" curricula.
- Monitor the demands and motivations of their membership and continually assess their ITS training and education needs (for a needs assessment framework, refer to *Building Professional Capacity in ITS: Documentation and Analysis of Training and Education in Support of ITS Deployment*).
- Build awareness of the ITS Professional Capacity Building program.
- Help their members gain access to PCB information and materials.
- Share presentation materials with other groups, allowing them to adapt materials to audiences as needed.

Based on these roles, the following actions can be taken by the PCB academic partners to assist in the overall PCB efforts:

Immediate Actions

- Access the course and seminar materials of the U.S. DOT ITS PCB Program. Review them, modify them to meet audience needs and incorporate them into degree programs and curricula.
- Develop and deliver new ITS courses to future transportation professionals, as part of degree programs, and to current professionals as part of continuing education programs.
- For those with existing ITS courses and workshops that are delivered through traditional classroom teaching, consider using innovative media to reach a wider audience.

Near-Term Actions

- Work with the U.S. DOT ITS PCB Program to develop new courses that meet the top ten most critical learning needs of current professionals. Again, review and incorporate these courses into degree programs and curricula.
- Work with the U.S. DOT ITS PCB Program to develop hands-on workshops that teach skills.
- Work with the U.S. DOT ITS PCB Program to develop “model” curricula through a series of workshops and forums.
- Assist the U.S. DOT’s PCB Program in training the-trainers.
- Conduct needs assessments to target PCB course and seminar materials to local audiences.
- Assist in developing distance learning initiatives.

Appendix A: Brief Summaries of Previous Studies on Education Needs

It is recognized that there are no definitive or clear -cut answers to the question, “How should we educate the transportation professional of the future?” Universities are already in the process of attempting to answer that question by carefully evaluating their own transportation education programs. It is expected that the results of this project will assist those efforts.

Earlier studies and thoughtful papers prepared by academicians provide an excellent base to work from, as the report moves toward identifying the fundamental competencies that need to be taught at the university level. Following is a summary of the results from some of those studies, conferences and papers. They are:

- (1.) “Intermodal Transportation Education and Training,” TRB Conference Proceedings
- (2) “Developing a Market Sensitive ITS Education Program,” by Boile, Spasovic and Pignataro
- (3) “Professional Education in Transportation: A Prototype Masters in Transportation” by K. J. Steffel, Texas Transportation Institute
- (4) “Educating the ‘New Transportation Professional’,” by Joseph M. Sussman, MIT.
- (5) “Transportation Education for the 21st Century,” Lester A. Hoel, University of Virginia.
- (6) “Ideas for ITS Education and Training: Coordination Among Institutions,” Kan Chen.

(1.) “Intermodal Transportation Education and Training,” TRB Conference Proceedings

Core competencies should be defined by academia and stakeholders for all levels of entry into the workforce. The concept of core competencies was viewed by many (at the conference) as a key point of departure for education and training programs. These core competencies should be developed jointly by all major stakeholders and constituencies and should provide input for program development.

Conference participants identified a set of competencies or skills that could apply to any level or position as well as to any field in transportation. These “core competencies” included the following:

- **Technical competence:** No matter what the task, individuals must be technically competent to perform it successfully.
- **Teamwork:** Being able to work effectively as a team is becoming one of the most critical characteristics of today’s workforce.
- **Role of measurement:** Implied by measurement is any level of mathematical reasoning, from basic mathematical skills to the development of mathematical models.
- **Communications:** One of the important needs, and a real challenge to educators, is developing student skills in technical communications.
- **Critical thinking:** Referred to by some as “problem solving,” in essence this skill involves the ability to figure out the logical path from an existing status to a desired one.

These core competencies are generic in the sense that they could be applied to any type of position. Conference participants also identified higher-level skills and knowledge that were appropriate for those involved with intermodal transportation:

- **Customer orientation:** Given the market context for intermodal transportation, the transportation workforce must understand customer desires and needs.
- **Systems perspective:** Intermodal transportation requires a systems perspective in the planning, operations, and management of services and facilities.
- **Economics and forecasting:** A basic understanding of how economies operate and how transportation fits into this economic context is needed.
- **Data, modeling, and information systems:** In a complex world, transportation officials need to understand how to use data in a decision support context, which could include developing models and information systems.
- **Basic research understanding:** These skills include developing research designs, conducting experiments, and drawing conclusions.

As an example of how different levels of competency can relate to different levels of education, one conference group developed illustrative programs at different levels of entry for those interested in ITS. For example, two-year programs should include computer-assisted drafting and design (CADD), computer programming, electronics, quality control, and traffic control systems. Undergraduate programs should include a broad understanding of other engineering disciplines, crosscutting skills such as those in communications and business, and problem solution. Graduate programs should include broad knowledge of a major field and a subspecialty, computer tools, ITS and management information systems, and related multi-disciplinary courses.

(2) **“Developing a Market Sensitive ITS Education Program,” by Boile, Spasovic and Pignataro**

Relevant excerpts from that paper include the following:

- There is a consensus between public and private sectors on the one hand, and academia on the other, on the importance of an “ITS education.” An ITS education on both the graduate and undergraduate level is essential.
- It seems that the academic programs are aware of the educational needs of the private and public sectors in ITS and have been reacting to those needs. Academic institutions are improving their existing curricula to reflect the role of ITS by either introducing new courses, or revising existing courses to include course-related ITS aspects.

ITS is an interdisciplinary area. The nature of the interdisciplinary aspects of ITS is reflected in the existence of ITS groups consisting of professionals from various backgrounds and educational levels. This is especially true in the private sector. A traditional civil engineering curriculum needs to be revised to better educate engineers in ITS, thus the ITS educational program must be inter (or cross) disciplinary. The interdisciplinary element should facilitate team work in “ITS Groups” of the private - public sector organizations which, according to the survey, consist of engineers, non -engineers, and technicians from many different disciplines.

- Students should be educated in areas that are not traditionally part of civil engineering education. These include communications, traffic surveillance, systems analysis, social and institutional issues.
- A dedicated degree in ITS is not considered to be essential, since, as some respondents are concerned, it could confine ITS education to several narrow courses. However, a core ITS program open to various disciplines such as civil, systems, electrical, computer, industrial and mechanical engineering; and computer, information, planning, management, and social sciences will help students from various disciplines to acquire a proper ITS education, and relate their careers to ITS needs.
- ITS projects are accomplished by groups; thus team work is essential. To prepare students for this, it is important that their ITS educational experience incorporate teamwork with students from various disciplines working together. It seems that the academic programs have recognized this and are emphasizing teamwork through student involvement on real -world ITS projects.

(3) **“Professional Education in Transportation: A Prototype Masters in Transportation” by K. J. Steffel, Texas Transportation Institute**

This report states:

“Current transportation education, as seen from the survey results and supported by Shen and Sheridan, 1991, occurs mainly through civil engineering curricula. The transportation environment is rapidly changing, and transportation policy-makers face challenges beyond the design and construction of the transportation system. The next generation of transportation policy-makers must have not only technical skills and an understanding of systems and their operations, but also sufficient management and “people” skills. These skills will help them to meet the challenge of comprehending and fulfilling the demands of society (ITE, 1990; Khisty, 1988). In addition, they must do so in a politically influenced climate and make decisions with a decreasing allocation of already limited resources (Khisty, 1988). Therefore, to account for the evolution of the transportation environment, the transportation education curriculum must be reformulated.”

Based on this insight, TTI recommended a new graduate level program to create a multi-disciplinary graduate transportation degree that would shift the focus from a single discipline to multiple academic areas. The new degree would go beyond current inter-disciplinary programs, giving relatively equal weight in three main areas: Systems Analysis & Design, Transportation Planning, and Management and Economics, supplemented by other electives.

- **Systems Analysis & Design** — The engineering college will coordinate this subject area. Course requirements would include:
 - *A Newly Designed Composite Core Class;*
 - ITS;
 - Traffic Flow/Modeling/Engineering;
 - Highway Engineering and Design;
 - Materials;
 - Transportation Systems Engineering and Operations;
 - Infrastructure Engineering;
 - Environmental Engineering.
- **Transportation Planning** — The urban/city/regional planning colleges will coordinate this subject area. Course requirements would include:
 - *A Newly Designed Composite Core Class;*
 - Transportation Planning and Analysis;
 - Community and Regional Planning;
 - GIS and Computer Graphics;
 - Planning Theory and Methods;
 - Environmental Impact Assessment.
- **Management and Economics** — The business and economic colleges will coordinate this subject area. The course requirements would include:

- *A Newly Designed Composite Core Class;*
 - Management;
 - Budgeting and General Accounting;
 - Transportation Economics;
 - Financial Management;
 - Logistics;
 - Public Finance;
 - Economic Development;
 - Public Policy;
 - Human Factors and Resources.
- **Other Electives**
 - Public Speaking;
 - Technical Writing;
 - Speech Communications.

Specifically addressing the topic of undergraduate curriculum are several thoughtful papers, all of which provide themes that are consistent with the findings from this study's interviews. Following is a summary of several selected papers and relevant recommendations from those papers.

(4) “Educating the ‘New Transportation Professional’,” by Joseph M. Sussman, MIT.

In addressing undergraduate education needs, Sussman suggests that academic programs focus on education in the broadest sense rather than training students in a narrow way. He proposes that university education focus on transportation fundamentals that include an understanding of:

- Technological advances, to include:
 - an understanding of the role of changes in technology
 - the pressure on transportation to integrate new technologies with the environment
 - how advanced technologies will fundamentally change the transportation profession.
- The systems methodologies fundamental to the analysis or design of transportation systems, to include:
 - probability and statistics;
 - optimization theory;
 - macroeconomics;
 - network analysis tools;
 - transportation modeling.
- The broader context of where transportation fits in a societal/political/institutional framework.

But he also suggests that additional “breadth” is required to include:

- modern communication systems and telecommunication policies;
- sensor and control technologies;
- advanced engineered materials and their uses;
- human factors;
- information networks;
- systems methodology; and
- institutional issues.

(5) “Transportation Education for the 21st Century,” Lester A. Hoel, University of Virginia.

Hoel suggests that in training the transportation professional of the future, the first step is to begin with determining how the bachelor of science or bachelor of arts degree can be used as the essential step in a system of lifelong learning. He suggests seven elements:

- Basic knowledge of mathematics and science and its application to transportation problems;
- Language and communications skills including writing, public speaking, and the ability to interpret technical and non-technical literature;
- Basic knowledge of applied sciences that are relevant to transportation;
- Understanding and familiarity with computers, including programming, applications software in word processing, spreadsheets, data management, telecommunications skills and transportation applications;
- Understanding the interrelationships between technology and society, both nationally and globally and the context within which the transportation professional works;
- Familiarity and experience with the elements of transportation systems including planning, operations, design, maintenance and management in an intermodal context; and
- Awareness of the impacts of transportation on society including social, economic and environmental concerns as well as the importance of ethics in modern professional practice.

In addition to the above, he suggests that the 21st century professional should also be prepared to meet the new challenges of working in a global environment. Thus, universities must also prepare students to meet the new challenges of global and managerial competition.

Consequently, he suggests that several additional themes should be included in the curriculum:

- Study of at least one foreign language with follow-up travel and experience in a country where that language is used;
- Study abroad opportunities and international exchange programs for faculty and students;
- Placing greater emphasis on practice and industry concerns; and
- Introduction to economic, business and trade aspects of international engineering with emphasis on those elements that differ from U.S. experience.

(6) **“Ideas for ITS Education and Training: Coordination Among Institutions,”**
Kan Chen.

In another paper, Chen suggests that curricula for education programs are mainly intended to educate professionals to meet long term unpredictable future needs. Thus , university curricula materials need to be developed to provide students with basic principles before leading them step-by-step to a more thorough grasp of advanced knowledge.

The findings from these reports are representative of other reports. Additionally, they confirm the findings of the interviews.

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